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NEW YORK, APRIL, 1892.

THE National Electric Light Association ought to change its name by dropping the "Light," if the proceedings of its last meeting are an indication of the work done by its members. Comparatively little was said about the electric light; nearly all the papers read and nearly all the discussions having reference to the transmission of power by electricity and the use of electricity in operating railroads and machinery of various descriptions. With the rapid development of electrical science these applications are becoming of very much greater importance than the lighting, and electrical engineers are now and are likely to continue to be occupied more and more with these applications of power.

THE wooden vessels of the Navy are fast disappearing, and their final condemnation will be hastened by a provision in the Naval Appropriation Bill which reduces the limit of repairs which may be put on them from 20 to 10 per cent. of the original cost.

A special exception, however, is made in the case of the *Hartford* and the *Kearsarge*, and those two ships will be kept in commission in consideration of the notable services they have rendered in the past.

THE *Directory* of the American Steel & Iron Association reports that 52 new blast furnaces were built last year —1 for using anthracite coal, 16 for charcoal and 35 for coke or bituminous coal. There were 58 furnaces abandoned or torn down; but the reduction is apparent only, as the capacity of the new furnaces is considerably greater than that of the old ones, nearly all of those abandoned having been small furnaces. The addition to the rolling mill capacity was also considerable, 43 new mills having been built during the year and 28 given up. Here, as with the blast furnaces, the new mills are generally of larger capacity than the old ones abandoned.

SIX new Bessemer steel plants have been established during the year, making 46 plants of that kind now in the United States, with 95 converters. In addition to these there are 5 Clapp-Griffiths and 4 Robert-Bessemer steel plants, having together 15 converters. The making of open-hearth steel has also had a large growth, 17 new plants having been built, making 71 plants of this kind now in operation, with 5 new ones in the course of erection. The production of basic steel has made considerable progress, but has not yet risen to a position of importance. The crucible steel works about hold their own, and there are now 45 plants of this class in operation and 1 under construction.

IT has been supposed that the extending use of Bessemer was driving wrought iron out of the market; and some experts have even predicted that puddling would become a lost art. This does not appear to have been the case, however, for the Association reports 5,120 puddling furnaces in operation, an increase of 206 in three years. Accepting these figures, it can hardly be said that steel is replacing wrought iron. Perhaps it would be better to say that the increased demand for metal for general structural purposes is being met by steel rather than by iron. The rail business was not good last year; but the deficit in this direction seems to have been almost, if not quite, made up by this demand for steel for other purposes.

STATISTICS are exceedingly valuable; but as the careful student well knows, nothing can be more misleading or more provoking than statistics carelessly gathered and stated without proper order or method. Too much of this kind of work is done, and the time and effort spent in doing it is utterly wasted so far as any good result is concerned. A chaotic mass of figures may impress some persons with a sense of authority, but a very slight analysis will show of how little value it really is. It is very irritating to see such so-called statistics, when we know that the same work, or less, would have produced really valuable results.

In this connection it may be well to quote a brief paragraph from Professor Meitzen's "History and Theory of Statistics," probably the best and most thorough work on the subject: "The things to be included in the enumeration must correspond entirely with the preconceived notion of the unit of enumeration. Nothing contained in the aggregate which corresponds to this idea can be passed by unnoticed. This is the indispensable condition of the correct enumeration, and therefore of paramount importance as the basis of the entire process."

This paragraph deserves to be most carefully studied by all who have to gather and arrange statistics.

ENGLISH AND AMERICAN LOCOMOTIVES.

OUR esteemed contemporary, *The Engineer*, in its issues of February 26 and March 4, is making itself merry over the data which we published some months ago concerning the performance of American locomotives. As hilarity is such a rare privilege in technical journalism, our contemporary may be left undisturbed in its paroxysm of merriment for another month before serious reflection is imposed on it.

We confess to a little surprise, though, at the admission which our critic makes in saying that:

"All we have contended is that American locomotives are less economical machines than English engines; and we have carefully avoided the complications which crop up the moment we begin to deal with the prices of coal, oil and labor. . . . It is, we think, expedient therefore to confine our attention strictly to the narrower and more manageable proposition with which we started, and compare English and American locomotive per-

formance on the basis of fuel burned and weights hauled, and leave on one side the discussion of prices."

In other words, the proposition which locomotives will do the work that they are intended for at the least *total* cost! *The Engineer* will not discuss. The urgent question which is pressing itself on the attention of every railroad manager in this and other countries is, How can the expenses of operating their roads be reduced? Competition and declining rates are daily presenting their peremptory demands for economy. What class of locomotives will perform the required service at the lowest *total* cost is the importunate question which no railroad manager can escape; the answer to which is often one side of a dilemma, and declining dividends or bankruptcy the other. The narrower question as to which engines burn the least amount of fuel per train or per ton mile we confess seems hardly worthy of further discussion; and its answer with any obtainable data is probably not now susceptible of satisfactory proof; and only careful and impartial tests of locomotives made under exactly the same conditions would give conclusive evidence with reference thereto. The broader question as to which class of locomotives performs the service in which they are used at the least *total* cost is, as we have said, one which is forced upon the attention of every railroad manager in the world.

An international test of locomotives during the Columbian Exhibition at Chicago would be of very great interest to railroad men everywhere.

We—and we believe we can speak for many of our readers—continue to regret that *The Engineer* is not disposed to publish engravings of a representative English locomotive in sufficient detail to show the construction of all its parts, so as to make what may be called an anatomical comparison of each possible. We renew our offer to furnish our contemporary either drawings or electrotypes of engravings—the size of the latter to be adapted to our pages and those of *The Engineer*—of a representative American express engine in exchange for similar illustrations of an English locomotive of corresponding class and capacity.

HOW DOES A LOCOMOTIVE PULL ITSELF?

THIS problem is a very old one, and was discussed at considerable length some time during the fifties, in Zerah Colburn's *Railroad Advocate*, and probably puzzled a good many people before that time. Nevertheless, it comes up in perennial periods, and seems always to be a novel subject to a new class of readers. Like the preachers, an editor must occasionally turn his barrel upside down and repeat his homilies to those who are happily younger than he is, but unhappily less experienced.

The discussion of this subject has just broken out afresh in the correspondence column of the London *Engineer*, and the usual amount of misapprehension of the subject has shown itself in letters which have been published. It has, therefore, seemed that a little fresh elucidation of the subject might not be unwelcome to some of our readers. Those who have crossed over the half century divide which separates the optimistic from the pessimistic periods of life, and whose capillatures show the effects of early autumn frosts, need not read what follows, as it is not likely to contain anything which will be new to them.

In this, as in many other discussions, the first and a serious stumbling block arises from the ambiguous meaning of a term. The problem, in fact, may, to some extent, be stated by the question, Where is the *fulcrum* of a locomotive driving-wheel? The definition of the word *fulcrum* given in Webster's Dictionary is "that by which a lever is sustained, or the point about which it turns in lifting or moving a body." Now if the whole of a lever moves while it is in action, it is often a matter of very great doubt where it is sustained. Take the case of what is called the "floating lever" of a car-brake. Here the power is applied usually between its two ends, and the whole lever is in motion. Either end may then be regarded as the fulcrum.

In books on mechanics it is usual to classify levers into three "orders." Thus, in Deschanel's "Natural Philosophy" it is said that "in levers of the first order, fig. 1, the fulcrum is between the power and the weight. In those of the second order, fig. 2, the weight is between the power and the fulcrum. In those of the third order the power is between the weight and the fulcrum." Now suppose that each of these "orders" of levers was a brake lever such as has been described, then whether the fulcrum is in the middle or at the end in the first and second orders would be altogether uncertain, and it would be equally so whether it was at one end or at the other in a lever of the third order. It is desirable, therefore, to ignore altogether the word *fulcrum*, and if we consider only the forces which act on a lever, it will make our explanation much more clear, and an understanding of the action of levers easier than it will be if we try to determine which is the fulcrum.

From fig. 1 it will be noticed that the power P and the weight W both exert a force downward, and if the lever rested on a support, C, which consisted of, say, a sharp

Fig. 1.

LEVER OF THE FIRST ORDER.

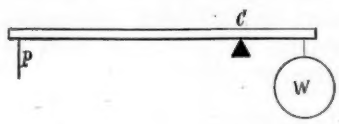


Fig. 2.

LEVER OF THE SECOND ORDER.

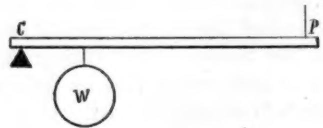
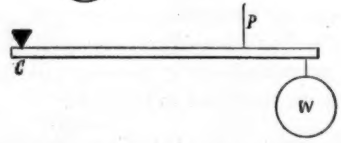


Fig. 3.

LEVER OF THE THIRD ORDER.



metal edge, it would make more or less of an indentation on the under side of the lever, showing that at that point there was a force, or reaction, if we choose to call it so, which is exerted upward in relation to the lever. It will be noticed that the forces at each end act in one and the same direction, and that which is exerted in the middle acts in the opposite direction. Now this is true of each of the other orders of levers. In fig. 2 P and C act upward and W downward, and in fig. 3 C and W act downward and P upward. Without going into a full elucidation of the elementary principles of the lever, it may be stated generally that the sum of the two forces acting on the ends is always equal to that acting in the middle and in the opposite direction. Thus, in fig. 1, $P + W = C$, in fig. 2, $C + P = W$, and in fig. 3, $C + W = P$. If, then, instead of designating these forces as the *power*, the *weight*, and the *force acting on the fulcrum*, we call the greater of the

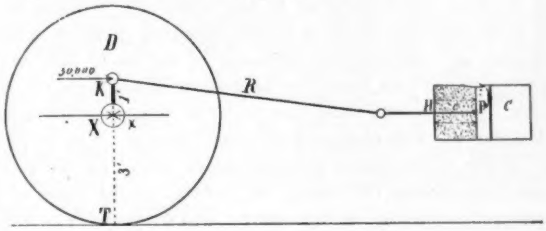
two forces which acts on the short end of the lever, and in the same direction as that acting on the other end, the *major force*, and the smaller force which acts on the long end of the lever the *minor force*, and that which acts on the middle of the lever and in the opposite direction to the end forces, the *counter force*, we will do much to clear up the ambiguity with which the whole subject is sometimes surrounded. In fig. 1, *P* is the *minor force*, *W* the *major force* and *C* the *counter force*; in fig. 2, *C* and *P* are the *major* and *minor* respectively, and *W* the *counter force*, and in fig. 3, *W* and *C* are the *major* and *minor* and *P* the *counter forces*. Now it is universally true that if the major and minor forces are added together, their sum will always be equal to the counter force, and, as stated, that they always act in opposite directions.

With this terminology it will be seen that there really is no difference in the principle of action of the levers of the different orders. In all of them the *major* and *minor* forces act on the ends of the lever and the *counter force* on the middle and in the opposite direction. The two forces acting on the ends may be exerted in any direction—that is, either up or down or sidewise; but, in any event, the counter force always acts in opposition to them. In figs. 1 and 2 *P* and *W* and *C* and *W* act downward, whereas in fig. 2 *C* and *P* act upward.

Having this clearly in our minds, we are in better position to understand how a locomotive pulls itself than we would be if we tried to determine which is the fulcrum in different positions of the cranks and pistons.

Supposing now that in fig. 4, *D* represents the driving-wheel of a locomotive, *C* the cylinder, *P* the piston, *R* the

Fig. 4.



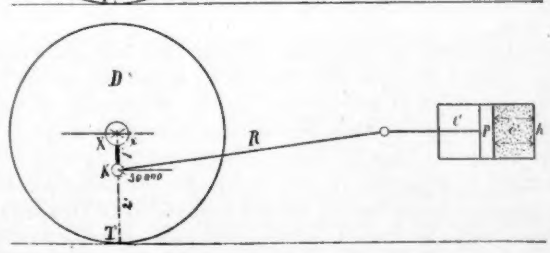


Fig. 5.

connecting-rod, *K* the crank-pin, and *X* the axle. It will be supposed, further, that the crank-pin is above the axle, as shown at *K*, and that the steam is acting in the back end *c* of the cylinder and is exerting a total pressure on the piston of 30,000 lbs., as indicated by the darts at *c*. Leaving out of account the effect of the angularity of the connecting-rod, this pressure is transmitted to the crank-pin, and is exerted in a forward direction, as indicated by the dart at *K*. It then acts on the spokes of the wheel, which may be regarded as a lever, *K X T*, *K* being the major force. It will be supposed that the driving-wheel is 6 ft. in diameter, and the stroke of the piston is 2 ft. The lever *K X T* will then be 4 ft. long, the short arm *K X* being 1 ft. and the long arm *X T* 3 ft. long; consequently, the counter force exerted at *X* will be equal to $30,000 \times 4 \div 3 =$ 40,000 lbs. This will tend to push the engine forward, or in the direction of the dart *X*. But while the steam is acting on the piston it also exerts an equal pressure on the back cylinder-head *H*, as indicated by the darts. The cylinder being fastened to the frame, this pressure is transmitted by it to the axle *X*, and tends to push it backward, as indicated by the dart *x* with a force equal to 30,000 lbs. Consequently there are two forces acting on the axle, one tending to push it forward with a force of 40,000 lbs. and the other urging it backward with a pressure of 30,000 lbs. The net result is a forward pressure of 10,000 lbs., which is communicated to the frame of the engine, and represents the tractive power of the cylinder.

When the crank-pin is below the axle, as shown in fig. 5, and steam in the front end of *c* of the cylinder is acting on the piston, then a backward force is transmitted to the crank-pin, and acts on a lever, *X K T*, as indicated by the dart at *K*. This is the counter force acting on a lever whose long arm *K T* is 2 ft. and whose short arm *X K* is 1 ft. long. Consequently the force exerted at *x* tending to push the engine backward is equal to $30,000 \times 2 \div 3 = 20,000$ lbs. At the same time, the steam exerts a pressure of 30,000 lbs. on the front cylinder-head *h* which is transmitted to the frames and to the axle, and is indicated by the dart *X*. Consequently there are two forces acting on the axle—one of 30,000 lbs. tending to push it forward, and another of 20,000 lbs. tending to push it backward, the net result being a force of 10,000 lbs. pushing the engine forward. The length of the darts *X* and *x* in the two figures are drawn to a scale, and their lengths represent the magnitude of the forces acting on the axle.

From this explanation it will be seen that it is not a matter of the slightest importance whether the point of contact with the rail or the axle is regarded as the fulcrum. All we need do to get a clear idea of the action of the forces is to understand their effect when applied to the wheels, as has been described. If any reader has any difficulty in comprehending how the steam acts, he may imagine that a small boy, endowed with a superhuman capacity of exerting a force of 30,000 lbs., is enclosed in the back and front ends of the cylinder respectively of figs. 4 and 5, and that he is pushing against the piston with his hands and against the cylinder head with his feet, and he—the reader, and perhaps the boy—will then have a clear idea of how the steam acts.

It is sometimes thought that a locomotive will start a heavier load when the crank-pin of one cylinder is above the axle than it will when it is below, because it is said the steam pressure is then acting on a longer lever in the wheel. This, it will be seen, is a mistake. A locomotive will exert its maximum tractive effort when the two cranks stand at angles of 45° with a vertical or a horizontal line and are behind the axle. The tractive force which can then be exerted with any pressure of steam in the cylinder will be considerably greater than it is when the cranks stand at the same angle and are both in front of the axle. This is due not to any difference in leverage, but to the influence of the angularity of the connecting rods. When both cranks are above or below the axles and stand at angles of 45° to a horizontal or vertical line, the tractive force which will be exerted with a given steam pressure will be the same.

WIRE-WOUND GUNS.

A TRIAL of the Brown segmental wire-wound system was had at Birdsboro, Pa., February 26, and if certain press reports of this experiment are accepted, one might believe that the problem of gun construction had been settled for good and all.

Following the specifications of the letters patent in this case, granted in 1889, the Brown gun may be described as made up of a number of longitudinal sections or segments of a circle, fitted together laterally, preferably with tongue and groove, around which wire is wound from breech to muzzle, and over this is a thin outer shell of steel for the protection of the wire. The joints, or meeting edges of the segments, may run straight from breech to muzzle, or be spiral, following the grooves of the rifling. No special method of securing the breech-block is provided for.

The experiment referred to was made with a cylinder, representing a section of the 5-in. Brown gun, 16 in. in length, with an internal diameter of 5 in. and an external diameter of 15 in. Twelve segments, 3 in. in thickness, and 2 in. of wire in 31 layers, made up the 5-in. thickness of metal around the bore. The two ends of this hollow cylinder were closed with plugs; the lower one—the cylinder was set on end for firing—had two pressure gauges secured to it, and the upper one was a vent 2 in. in diameter to afford access to the charge and to allow for the escape of gas. One preliminary and four other charges were fired, of from 2½ to 3½ lbs. of Dupont powder, with recorded mean pressures of from 35,200 to 53,850 foot-pounds.

Granting that the recorded pressures were correct, it is not easy to understand the value of this experiment in determining the merits of this system of gun construction. While the experiment clearly shows that a number of short, carefully-made staves of metal supported at both ends and wound with steel wire of high quality, will withstand great pressure without rupture, it in no wise shows that a 35-caliber finished gun, constructed upon the same lines, would withstand anything like the strain recorded in the experiment under consideration.

It is hardly necessary to recall the fact that since the first experiments with wire-wound guns, nearly forty years ago, down to the present time, it has not been a want of strength to resist transverse rupture, but longitudinal weakness that has stood in the way of success of the wire-wound gun. The failures of Longridge, Schultz, and others abroad, and of Woodbridge in this country, all go to show how difficult it is to prevent such guns from pulling apart in the direction of their length, while, given good materials, there is hardly a practicable limit to the strength that can be given to such guns to resist transverse strain alone.

If one were to venture upon a criticism of the system in advance of its thorough test, it would be to point out what seems to be two grave defects: (1) the seating of the breech-block, not as in the ordinary built-up gun, either in the thick, solid inner tube that forms the bore of the gun, as in the French construction; or in a heavy, substantial jacket connected directly with the trunnions, as in our own—but in the rear ends of a dozen, more or less, of individual staves or segments of metal, and (2) in the presence of a greater or less number of joints along the interior of the bore. When one remembers the tremendous scoring effect of powder gases of high temperature and tension upon the bore of a gun, and their insinuating quality, one may well apprehend serious consequences from this method of construction.

The press reports speak of a thin inner tube or lining as entering into the construction of the gun, but no mention is made of it in the patent specifications before us. The unlucky experience of the English with "liners" for their heavy guns does not lead one to put much confidence in this device.

Extended criticism of this and of other systems of wire-wound gun construction may well be postponed until the guns now being built are brought to the trial butts. A 5-in. Brown, a 10-in. Woodbridge, and a 10-in. Ordnance gun are likely to come to trial during the present year. The success that has recently been met with in the English and Russian gun factories in the fabrication of wire-wound guns, prepares one to believe that the coming gun may be one of this character.

THE MASSACHUSETTS COMMISSION REPORT.

THE Massachusetts Railroad Commissioners' report, as usual, considers a variety of important topics. The first of these is the question of harmony in railroad legislation among the different States; and here reference is made to the action taken to prepare a general compilation of the railroad laws of several New England States and of New York in order to ascertain the variation in the laws of those adjoining States and the measures which may be taken to bring them more into accordance with each other.

A topic of somewhat similar nature is the question of safety appliances, the extent to which laws relating to them may be maae to harmonize with each other, and the degree to which federal legislation might extend. Under this head some attention is paid to the action taken by the Conference of Railroad Commissioners which was held in Washington last year.

In matters more peculiar to the State the Commissioners note a considerable advance in the adoption of steam-heating systems. All the leading railroads of the State now have a large number of cars fitted for heating by steam from the locomotive. The reports show that the total number of cars fitted in this way on Massachusetts railroads is now 2,291, or 73 per cent. of the entire passenger equipment, being an increase of 30 per cent. during the year. On several of the roads all the passenger trains will be next winter run without fire in any of the cars.

Some progress has been made in doing away with grade crossings. Only a few new ones have been authorized during the year, and those at unimportant points, where the highway traffic is very small, while proceedings have been taken in 93 cases for the abolition of such crossings, and in 20 cases work is actually in progress. In this connection the Commissioners call attention to the special danger involved in all crossings of railroad tracks by street railroads, and to the apparent increase of this danger where electrical cars are used.

Another subject nearly related to this is the somewhat difficult and intricate question of the grade crossings of the various lines entering Boston from the north and northeast. The present crossings of the Fitchburg, the Boston & Lowell, the Boston & Maine, and the Eastern tracks are a source of serious delay and danger, and the Board has had a careful examination of the question made and a plan submitted by their engineer for a rearrangement of the tracks and stations on these roads, which will not only do away with the railroad crossings, but will also prevent much of the obstruction to street traffic resulting from the present arrangement.

As to general statistics the railroad statements for the year show that there was 3,217 miles of road belonging to the companies which make returns to the Board. The business of

these roads shows a fair amount of increase, but this was more than balanced by the increase in working expenses, leaving a small decrease in net earnings. Both passenger and freight mileage show an increase, while the average earnings per unit of traffic remain about stationary. The increase in rolling stock was not large, probably not much exceeding that required by the gradual growth of the business. About the usual amount of improvement is shown, and the additional mileage laid with steel rails was about 10 per cent. of the whole.

Considerable space is given to the investigation of the Zone Tariff System, a work imposed upon the Board by a resolution of the Legislature last year. The working of this system in Hungary and Austria has attracted much attention in Europe, and to some extent in this country also. The Board presents statements which have evidently been carefully considered, as well as a comparison of the conditions existing in the countries named, and in Massachusetts, and comes to the final conclusion that the system presents no advantages which would warrant its present introduction in this country. The real advantage gained in Hungary was due to the great reduction of rates much more than to the simplification of the ticket system, and the adoption of the Zone system here would probably prove a hardship in many cases, besides making a much less equitable arrangement than the present system of basing fares on mileage.

NEW PUBLICATIONS.

VOLUME I: IRRIGATION CANALS AND OTHER IRRIGATION WORKS.

VOLUME II: THE FLOW OF WATER IN IRRIGATION CANALS, DITCHES, FLUMES, PIPES, ETC. By P. J. Flynn, C.E. Two volumes bound in one; 711 pages, 92 tables, 211 illustrations. Published by the Author, Los Angeles, Cal.; price, $8.

In these two volumes Mr. Flynn has undertaken to fill a gap in professional literature by a work for which he is peculiarly fitted by training and experience. Irrigation on a large scale is comparatively new in this country, and what has heretofore been written on the subject is of a very fragmentary nature, and is scattered through numerous reports, papers, and society proceedings, where it is by no means easy to find it; so that those engineers who have works of irrigation under their charge have found it difficult or impossible to avail themselves of the results of past experience.

Volume I of Mr. Flynn's book is devoted to Irrigation Canals and Irrigation Works generally, and here he has presented in a compact form a great body of information on past practice, not only in this country, but also in Spain, India, and other countries where lands have been irrigated for centuries. He has evidently searched out and obtained information from all available sources; but the book is not by any means a mere compilation, containing a great deal of original matter. The book treats not only of canals, but also of various other constructions—dams, reservoirs, weirs, and the like—and of systems of distributing and using the water after it has been carried to the points where it is needed. This volume has many illustrations showing methods of construction and notable examples of work.

The discussion of methods of actual irrigation—that is, the distribution of water to the land, will be of especial help to engineers. It is in this point that experience is most lacking in this country, and it is in these methods that waste and loss is most likely to occur. This discussion and the comparison of various plans is very full, and occupies a considerable part of the volume. Where irrigation is most needed water is usually scarce, and it is of importance that the available supply should be used to the best advantage, and that all waste should be prevented.

Volume II is devoted to discussing the flow of water in canals and in open and closed channels generally. Here Mr. Flynn has adopted the formulas of Kütter, D'Arcy, and Bazin, and treats of their application, which he has simplified by the preparation of numerous tables. Some of these have already been tested by use; and there can be no doubt that they will prove a very great convenience to engineers. They cover a great variety of channels of various forms, both open and closed, of various sizes and sections, and with different kinds of surfaces, covering about all the cases likely to be encountered by an engineer in actual practice.

Some space is also given to a special discussion of the flow of water in sewers, pipes, and closed conduits, and in this comparison is made of almost all the formulas which have been in use or proposed. The results appear in the form of numerous tables, simplifying very much the application of the formulas approved and adopted. This part of the book will be of value to engineers engaged in any kind of hydraulic work.

The whole book constitutes an exhaustive and valuable treatise, and the author has produced a work which ought to be thoroughly appreciated by engineers, and which is evidently the result of long study and experience and of much labor.

The book is well printed in clear type, and is an excellent specimen of book-making. One point which deserves commendation is the use of large type for the tables, avoiding the appearance of crowding, and the fatigue to the eyes which too often results from reading tabular work. A very full index, which is appended, leaves little to be desired in the book.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. *Vol. XII., XXIId Meeting, Richmond, Va., Nov., 1890. XXIIId Meeting, Providence, R. I., June, 1891.* (New York. Published by the Society.)

This volume of 1,074 pages gives very convincing evidence of the prosperity of the Society. It contains 47 different papers —on a range of subjects whose scope is too wide to describe in a notice of this kind—besides addresses and discussions on other topics pertaining to the objects of the Society. In a preliminary note it is also said that the increasing bulk of the annual volume of *Transactions* has induced the Publication Committee to discontinue the insertion of the full list of members among the preliminary matters therein. The summary of membership shows that the total number is 1,344, which with the "Proceedings" is indisputable evidence that the Society is prospering. Of course, this prosperity is not correctly measured by the bulk alone of its *Transactions* or the number of its members, but these show that the Society is in a position in which it can safely exercise the privilege of exclusion of papers from its publication and candidates from its roll. The degree to which this privilege is wisely exercised will in future be indicative of the real prosperity and usefulness of the organization.

The range of subjects discussed in the volume before us is a very wide one, and shows how the profession of the mechanical engineer is extending. There are papers on Cable Road Construction; Chimney Draft; Properties of Ammonia; Properties of Sulphur Dioxide; Efficiency of Vapor Engines; Heat Transmission; Regulation of Injection Water to Condensers; Flexible Tubing; Hydraulic Traveling Cranes; Lubricants; Rope Driving; Accident Providing Devices; A Process of Cutting the Teeth of Spur Wheels; Single-Acting Compound Engine; Hydraulic Hoisting Plant; Latent Heat of Ammonia; A 75-Ton Refrigerating Machine; Experiments with Lubricants; An Engineering Problem at Richmond; Steam Jackets; Duty Trials of Pumping Engines; Rope Haulage; Triple-Expansion Engine; Blast Furnace Blowing Engine; Belt Dynamometer; Subdivision of an Index Wheel; Belt Testing Machine; Steel Castings; The Perfect Screw Problem; Steam Engine Efficiencies; Hirn's Analysis; Premium Plan of Paying for Labor; Experiments with a Screw Bolt; Calorimeters; Steam Jacket; Steam Reaction Wheel; Jib Propul-

sion; Flexure of Thin Elastic Rings; Mechanical Stoker; Economy of Compound and Single Cylinder Corliss Engine; Manganese Steel; Performance of a Worthington Pumping Engine; Heat Transmission through Plates Pickled in Nitric Acid, and Topical Discussions.

BOILER TESTS. *Embracing the Results of One Hundred and Thirty-seven Evaporative Tests made on Seventy-one Boilers, Conducted by the Author.* By George H. Barrus, S.B. Published by the Author, Boston.

The title of this book is sufficiently explanatory to give an idea of its scope; and in the introduction the Author says that its chief object is "to give a review of the various results and a consideration of the general subject of economy in the generation of steam, as revealed by the tests."

This the Author has done in a way which should earn for him the gratitude of the whole profession of mechanical engineers.

After describing the methods of conducting the tests, he makes a comparison of boilers which produce saturated steam with those which produce superheated steam. The first class, he says, are, as a rule, of the horizontal tubular type, and the second class of the vertical type. It is then shown that although the latter, owing to insufficient heating surface, will not evaporate as much water per pound of coal as boilers of the horizontal tubular type do, yet, owing to the greater value of superheated steam, the economy of the vertical type is often nearly or quite equal to that of horizontal boilers.

Proceeding to the consideration of the "General Conditions which Secure Economy," it is shown that the highest results are produced where the temperature of the escaping gases is the least. In other words, the greater the amount of heat which is absorbed by the heating surfaces and the water in the boiler before the heat escapes up the chimney, the greater the economy, which ought to be very obvious, but which is often overlooked. The temperature of the escaping gases which will produce the best results the Author concludes is about 375° for anthracite and 415° for Cumberland (bituminous) coal.

The relation between the heating surface and the grate area which will produce the highest efficiency is also considered. The conclusion is that for anthracite coal it should be in the proportion of 36 to 1, and that either more or less produces a loss, when the rate of combustion does not exceed 12 lbs. of fuel per square foot of grate per hour. For bituminous coal the ratio should be from 45 or 50 to 1, and the conclusion is drawn that a "much larger amount of heating surface is required for obtaining the full efficiency of bituminous coal than for boilers using anthracite coal."

Another interesting conclusion deduced from the experiments is "that a certain minimum amount of tube opening is required for efficient work." The highest efficiency, he concludes, with anthracite coal is obtained when the tube opening is from one-ninth to one-tenth of the grate surface. For bituminous coal he concludes that the area of the tube opening should be from one-sixth to one-seventh of the grate surface.

A comparison is then made of the economy of different kinds of boilers, which is very interesting; but there is room here to give only the writer's conclusions. The form of horizontal boiler, he says, which with suitable proportions and operation can be depended upon to give the highest evaporation is the common horizontal return tubular boiler so widely used in New England factories.

Of the plain cylinder boiler it is said that it is of evident inferiority as an economical generator of steam. The vertical tubular boiler, when properly designed, the Author concludes, is at least equal to the horizontal boiler in economy.

The three cast-iron sectional boilers which were tested gave comparatively poor results; but this is attributed in a great measure to unfavorable conditions and to insufficient heating surface to grate area.

Of nine water-tube boilers which were tested, only one reached the standard laid down for economy. This one had a sufficient ratio of heating surface to grate area. All the others had a deficiency in the quantity of heating surface, and consequently a high temperature in the flue. "On the whole," the Author says, "the water-tube boilers may be considered to be equal in economy to the tubular boilers under the conditions of comparison determined upon—that is, when the conditions are favorable to economy."

"The general conclusion," he says, "to be drawn from all these comparisons is that the economy with which different types of boilers operate depends much more upon their proportions and the conditions under which they work than upon their type; and, moreover, that when these proportions are suitably carried out, and when conditions are favorable, the various types of boilers give substantially the same economic result."

A separate section is devoted to a comparison of the value of different kinds of coal, the general results of which are given in the following table:

NAME OF COAL.	Lbs. of water evaporated from and at 212 degrees per lb. of dry coal.
Anthracite, Broken	9.79
Cumberland, Bituminous	11.04
Anthracite, Chestnut	9.40
Anthracite, Pea	8.86
Two parts Pea and Dust and one part Cumberland	9.38
" " " " " " " " Culm	9.01
Nova Scotia Culm	8.42

Some tests were also made to determine the value of petroleum as a fuel, the conclusions from which the Author sums up as follows: "This means, in round numbers, that the price of oil must be less than one dollar per barrel, delivered at the boiler, in order that the cost of fuel and labor for a 1,000 H.P. plant shall be equal to that which obtains when Cumberland coal is used at $4.56 per ton."

In making experiments, Mr. Barrus made some observations on the effect which the form of setting has when the boiler is externally fired. His conclusion is that the matter is of comparatively little importance, and that the plan to be followed is the one which will secure the simplest and at the same time the most convenient arrangement.

On the effect of admitting air into the furnace above the fire, he concludes that a considerable advantage—from 6 to 8 per cent.—attends the admission of air above the fuel when bituminous coal is employed, the amount of gain depending somewhat upon the method employed, but that little or no benefit is derived when anthracite coal is burned.

On the effect of feed-water heaters placed in the flues he shows that in cases of reasonably good practice the evaporation of water per pound of coal was increased very nearly 10 per cent. by their use. For a plant of 1,000 H.P. the Author estimates a saving from the use of a feed-water heater, with coal costing $4.56 per ton, at $1,759 per year. The cost of a heater with complete equipment of setting and appurtenances is from $7,000 to $8,000. The saving would therefore pay a yearly return of from 20 to 25 per cent. on the additional investment. Obviously, if coal cost only half as much, the saving by the feed-water heater would be only from 10 to 12½ per cent. on its cost, which is not more than a prudent business man would allow annually for interest, repairs, and deterioration, so that the conclusion would be that feed-water heaters are economical when coal costs more than $2.28 per ton, but are not if it costs less.

The second part of the volume before us gives detailed reports of the tests and engravings of various boilers tested by the

Author. The reasoning, inferences and conclusions drawn from these tests are given in the first part, from which we have made liberal quotations. In this way the whole subject is admirably presented, and in such a form as to economize the reader's time and attention as much as possible, the importance of which is often lost sight of by those who write for busy men's reading. The book contains about 70 diagramatic engravings of boilers and their settings.

In the appendix descriptions are also given of the Author's coal and steam calorimeters, with a report on the heating power of various coals.

Altogether the book is an admirable one, and cannot be too highly commended to all steam users and engineers interested in boiler use and construction. An especial feature worthy of praise is the absence of mathematical gymnastics, with which so many writers on technical subjects now befog the subjects which they attempt to elucidate.

THE TRANSITION CURVE FIELD BOOK AND GENERAL TABLES. By Conway R. Howard, C.E. John Wiley & Sons, New York.

The use of transition curves and their value are well known to engineers in railroad practice, and a field-book specially devoted to the subject is of service in a great many cases. The object of the present one is, perhaps, best explained in the words of the author:

> The aim of this Field-book is to furnish plain, practical rules and examples for guidance in adjusting and locating a curve, nearly identical with the cubic parabola as a transition curve in connecting circular curves with tangents.
>
> In the investigation of the principles upon which the rules are based, it will be seen that with data consisting in great part of familiar approximations used in circular-curve location, and with no mathematics beyond a little algebra and trigonometry, practically exact results are reached in regard to laws of the transition curve and its relation to circular curves.
>
> By means of transition curves of less than 15° of central angle, tangents can be connected with all circular curves used on railroads, their combined location presenting little if any more difficulty than ordinary circular-curve location.

Mr. Howard presents a general statement, followed by a number of cases of frequent occurrence in location. This is supplemented by the tables which the engineer is likely to need in his field work. The whole makes a practical and convenient handbook and an excellent companion for the engineer.

TRADE CATALOGUES.

Catalogue of the Niles Tool Works, Manufacturers of Iron and Steel Working Machinery, Railroad, Car, Boiler and Machine Shop Equipments. Hamilton, O., 1891.

This very handsomely printed and illustrated catalogue describes a large number of machine tools, including lathes of various kinds, planers, shapers, slotting machines, drill-presses, boring machines, etc. The quality of the tools made by these works is well known; but perhaps the variety will be better appreciated after a study of this catalogue, from which a complete equipment for a large shop can be readily selected.

The Meneely Bearing Company: Patented Tubular Roller Journal Bearings for Railroad Cars. Third Edition, 1892. *West Troy, N. Y.*

This pamphlet gives an illustrated description of the roller bearings made under the Meneely patent, with some statements of the experience had with them in actual service. This has certainly shown a remarkable degree of economy, with experience extending over a considerable time.

What Visitors Will be Shown at the World's Fair by Merchant & Company. Philadelphia.

This is a very amusing catalogue of exhibits, showing the supposed adventures of the representatives of a number of different nations at the World's Fair, while engaged in viewing the superlative exhibit of metals made by Merchant & Company, and that of the contrary class by their competitors. It should be seen to be appreciated.

The MacKnight Flintic Stone Company, New York. Illustrated Catalogue.

This catalogue shows a number of applications of the artificial stone made by the Company in pavements, sidewalks, fireproof roofs and floors, stables and machinery beds. It contains a description of the methods of manufacture and some other interesting matter. Like all engineers of experience, the managers of this Company evidently recognize the value of a good foundation for a roadway.

The Egan Company, in Cincinnati, O., has issued a large poster for distribution in South American countries, having a view of their shops and small illustrations of a large number of woodworking tools made there. A single glance at this is sufficient to show the extent of the Company's business and the extraordinary variety of tools which it is ready to supply.

The Lukenheimer Brass Manufacturing Company, of Cincinnati, O., have gotten out a unique calendar for 1892. It is on a card a little larger than the new postal card, and has stamped on it an excellent perspective view of the "Handy" gate valve which is made by the Company. The valve proper is in sight, and on the face of it is the invitation, "Investigate the handy;" by moving a small paper lever the valve is opened, and one reads the prophecy, "the coming gate valve."

CURRENT READING.

A NEW series of articles on the Poor of Great Cities is begun in SCRIBNER'S MAGAZINE for April. In the same number the new Gold Fields of South Africa are described, and there are illustrated articles on the New Parks of New York City and on Historic Moments. The number is one of unusual interest.

The March number of OUTING describes the organization of the Connecticut National Guard, and gives some excellent descriptions of the Pacific islands. The illustrations include some striking reproductions of instantaneous photographs.

The OVERLAND MONTHLY for April has an unusual number of illustrated articles. These include one by Professor Holden, of the Lick Observatory; one on the Water Front of San Francisco, and another with a series of Indian pictures of much interest. Besides these there is the usual variety of stories and sketches, making an exceedingly readable number.

A new edition of the standard TREATISE ON HYDRAULICS, by Professor Mansfield Merriman, is now in preparation by Messrs. John Wiley & Sons, New York. The same firm have also in press a Text-book on RETAINING WALLS AND MASONRY DAMS, by Professor Merriman.

In the ECLECTIC MAGAZINE for March there is the usual selection of articles from English magazines, covering a wide range of subjects. Two of the more notable are M. Flammarion's on Inter-astral Communication, from the *New Review*, and Professor Crookes' on Some Possibilities of Electricity, from the *Fortnightly Review*.

The April number of the POPULAR SCIENCE MONTHLY continues Mr. Carroll D. Wright's Lessons from the Census by a valuable paper on Rapid Transit in Cities. Professor Jastrow has a study of Involuntary Movements, and the Great Earthquake of Port Royal is described by Colonel A. B. Ellis. There are several other papers which deserve a careful reading.

The JOURNAL OF THE UNITED STATES ARTILLERY is a new periodical issued from the Artillery School at Fort Monroe. The first number has several papers of much technical value, and the editors deserve credit for its excellent appearance.

In recent numbers of HARPER'S WEEKLY there have been several articles of notable excellence. These include one on New Approaches to New York, describing the various plans for tunnels and bridges proposed for the Hudson and East rivers; one on the Wire-wound Gun, and one on the Movement for Better Roads.

Few of the magazines maintain a higher standard than the ARENA; the April number is a marked instance of this, and shows that the advanced position it has taken as an exponent of independent thought is well maintained.

Messrs. Richard H. and William H. Edmonds have retired from the management of the MANUFACTURERS' RECORD of Baltimore, which will hereafter be conducted by Messrs. Walter H. Page, E. H. Sanborn and T. P. Grasty. The RECORD has been a remarkably successful paper, and has done much good work in assisting the industrial development of the South.

The contents of the ENGINEERING MAGAZINE for March include articles on the Peary Expedition; What an Architect does for his Money; the Telephone Industry; the Manufacture of Ice; Dangers from Tall Office Buildings; Purification of Water, and several others by well-known engineers. It has also the fourth of Dr. Coleman Seller's papers on American Supremacy in Mechanics.

The March number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE is full of short articles on geographical topics, and is quite as bright as usual. This magazine always has something well worth reading.

In HARPER'S MAGAZINE for April Mr. Julian Ralph's papers on the Great Northwest are continued by one on Lake Superior, and the same writer discusses Western Methods of City Management. A paper on the Ancient Lake Region of America deserves note, and there are several very handsomely illustrated articles.

A new venture in the engineering field is CASSIER'S MAGAZINE, the February number of which has some very good illustrated articles. The subjects treated include Automatic Sprinklers; Corliss Valves; the Injector; the Forging Press; the Production of Aluminum; Rotary Engines; the Band Saw Mill, and several minor topics. The magazine is handsomely printed and the illustrations very good.

BOOKS RECEIVED.

Annual Report of the Chief of Engineers, United States Army, to the Secretary of War for the Year 1891. Brigadier-General Thomas L. Casey, Chief of Engineers. In six parts. Government Printing Office, Washington.

Geological Survey of Missouri: A Preliminary Report on the Coal Deposits of Missouri. Arthur Winslow, State Geologist. With 131 maps and illustrations. State Geological Survey, Jefferson City, Mo. This very valuable report is an evidence of the careful and thorough work which is now being carried out in Missouri.

Practical Carriage Building: Comprising Short Practical Articles on Carriage and Wagon Building, etc. Volume I. Compiled by M. T. Richardson, Editor of the *Blacksmith & Wheelwright.* The M. T. Richardson Company, New York; price, $1. This is a very useful and practical hand-book for carriage builders, containing much information which must be useful to them, and indeed to all wood-workers.

The Metal Worker Essays on House Heating by Steam, Hot Water and Hot Air. Arranged for publication by A. O. Kittridge, Editor. David Williams, New York. This is a reprint of several essays which appeared in the *Metal Worker*, and which were written in response to an offer of prizes for the best articles on the subject.

Lake Superior Iron Ore Production for the Past 36 *Years.* The *Iron Trade Review*, Cleveland, O.

Technical Conditions for the Preparation and Testing of Portland Cement in Russia. By Professor N. Belelubski. W. F. Häcker, Riga.

Timber Physics: Part I, Preliminary Report. Compiled by B. E. Fernow, Chief of the Forestry Division, Department of Agriculture.

Mineral Products of the United States, Calendar Years 1880 *to* 1890. Department of the Interior, United States Geological Survey; Major J. W. Powell, Director. This large table, prepared by Professor David T. Day, Chief of the Bureau of Mining Statistics, is exceedingly convenient for reference, giving the figures in a condensed form.

Census of Canada, 1891. *Bulletin No.* 4: *Population of the Province of Quebec.* Department of Agriculture, Ottawa.

Proceedings of the Ninth Annual Convention of the Roadmasters' Association of America; held in Minneapolis, Minn., September 8, 9 *and* 10, 1891. Published by the Association; J. H. K. Burgwyn, Secretary, Grand Rapids, Michigan.

Annual Report and Statements of the Chief of the Bureau of Statistics, Treasury Department, on the Foreign Commerce and Navigation, Immigration and Tonnage of the United States, for the Yead ending June 30, 1891. S. G. Brock, Chief of Bureau. Washington; Government Printing Office.

Winnipeg, the Heart City of North America: Illustrated. Winnipeg, Manitoba; the Stovel Company.

Twentieth Annual Report of the Superintendent of Water Works, Bay City, Mich. E. L. Dunbar Superintendent. Bay City, Mich.; issued by the City.

Reports of the Consuls of the United States to the Department of State: No. 134, *November*, 1891; *No.* 135, *December*, 1891; *No.* 136, *January*, 1892. Washington; Government Printing Office.

India Rubber. Special Reports from Consuls of the United States in Answer to a Circular from the Department of State. Washington; Government Printing Office.

Annual Report of the Massachusetts State Board of Arbitration for the Year 1891. Boston; State Printers.

A LOCOMOTIVE PROBLEM.

A WRITER in *The Engineer* propounds the following interesting problem, which is submitted to our readers for solution:

PROBLEM.

Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

SOME CURRENT NOTES.

THE Lehigh Valley Railroad is making some tests of a two-cylinder compound engine of the type designed by Mr. F. W. Dean, of Boston. The engine is of the consolidation pattern, has eight 50-in. drivers and a boiler 58 in. in diameter. The driving-wheel-base is 14 ft. 10 in. and the total wheel-base 22 ft. 10 in. The total weight is 125,600 lbs., of which 109,100 lbs. are on the drivers. The high-pressure cylinder is 20 × 24 in. and the low-pressure 30 × 24 in., the two being connected by a pipe passing through the smoke-box, which serves as a receiver.

ON March 1, according to the tables of the *American Manufacturer*, there were 300 furnaces in blast, with a

weekly capacity of 193,827 tons; a decrease of five furnaces, but an increase of 820 tons capacity, from February 1. As compared with March 1, 1891, the report shows an increase of 50 furnaces in number and of 73,082 tons in the weekly capacity.

There is a large stock of pig iron on hand, and prices are very low. There is a general opinion among furnace owners in favor of reducing production, but no one seems ready to begin the movement.

THE Legislature of Ohio has recently passed a law prohibiting the use of stoves on railroads in that State. The companies are given the option of using continuous steam-heating systems, hot air or hot water. A penalty of $1,000 and of $100 per day is provided for violation of the law.

THE New York Central Company has been notified that its present bridge over the Harlem River is an obstruction to navigation, and must be raised 24 ft. The necessary changes in grade of the approaches cannot be made without permission of the New York Legislature, and a bill for that purpose has been introduced.

To avoid some inconvenient street crossings which will be caused by the change, the company now offers to go back some two miles below the bridge and to build a viaduct from One Hundredth Street to the river, an arrangement which will leave all the street crossings clear of obstruction. The estimated cost of this arrangement is $3,000,000, and the company asks the city to pay one-half the cost.

THE whole matter of the Harlem River crossings has been the subject of so much bad engineering, so many botches and makeshifts, and so much trouble generally, that one is inclined to favor the latest proposition, which is to fill in the Harlem from Third to Eighth Avenue, and thus do away with question of crossings altogether. There are, of course, many objections to this, but it would be at least a settlement likely to remain.

AT the last meeting of the Western Railroad Club, Mr. Forsyth, of the Chicago, Burlington & Quincy Railroad, presented a paper on the strength of car couplers of the M. C. B. type. Mr. Forsyth estimated that there are now probably about 170,000 cars equipped with this coupler. On his own road the breakage amounted to about 7 per cent. of the whole number in use, of which 37 per cent. broke in the arms and 24 per cent. in the knuckles, more than one-half of them through the upper lug. In view of this he has been making some careful tests of couplers made of malleable iron and steel, these tests showing a wide variation in the strength of different types, and serving also to show the weak points in the design as well as the defects in the material. Mr. Forsyth concludes that malleable iron does not possess sufficient strength for the severe service required of a coupler, which in most cases is made to serve as a buffer as well. Cast steel he considers a much better material; but experiments are needed in the methods of casting in order to secure draw-bars free from blow-holes and defects. He would require a tensile strength of at least 125,000 lbs. for the sample coupler, and would provide that test bars must have tensile strength of 70,000 lbs. with an elongation of from 15 to 20 per cent. He also recommends the protection of the couplers by some form of buffer in order to relieve them from many of the violent shocks to which they are exposed.

THE ice-boat, as is well known to those who have used it, can be made to travel at a speed almost equal to that of the fastest locomotive, but it is dependent entirely upon the wind. A Poughkeepsie inventor, Mr. Mulrey, has devised an ice locomotive, or, rather, a steam-engine attachment for the ice-boat which will make it independent of the wind. The boat he uses is of the ordinary ice-boat form, is provided with a small boiler carrying 250 lbs. pressure of steam, and a small engine working on a pair of cogged drivers. Some experiments with this vehicle made on the Hudson River just before the breaking up of the ice were fairly successful.

COLONEL ALBERT A. POPE, of the Pope Manufacturing Company, has undertaken to stimulate interest in the improvement of roads by offering as prizes a large number of bicycles to young men writing the best essays on any phase of the road question. These essays are to be received before May 1 next. The Pope Company has expended a considerable amount of money in preaching the gospel of good roads, and proposes to continue in the same course.

THE Oerlikon Company, in Switzerland, one of the best and most successful manufacturers of electrical apparatus in Europe, has submitted plans for the transmission of power from Niagara Falls to Buffalo. The company has taken all the conditions into consideration, and believes that its plant will provide for all contingencies. They propose the use of units of 5,000 H.P. each at the Niagara stations; the three-phase current in transmitting the power and the use of transformers at the Buffalo terminus. The cost of the plant is given at above $180,000 per each unit of 5,000 H.P. for the complete plant, or $36 per H.P.

THE contract for draining Lake Angeline, in the Lake Superior mining region, has been let to C. B. Howell, of New York. This is quite a formidable undertaking, as the lake covers an area of 153 acres, and has a maximum depth of 43 ft. and an average depth of 20 ft. The contractor purposes using a centrifugal pump with a 20-in. suction and 22-in. discharge, having a capacity of 20,000 galls. a minute; the water is to be pumped into Carp River. The work is to be completed in five months. It is done for three mining companies—the Lake Superior, the Cleveland and the Pittsburgh & Lake Angeline—which own the adjoining lands, and have been working on mineral veins which extend under the lake. It is not considered safe to continue tunneling while the lake is full of water.

THE DE LA VERGNE REFRIGERATING MACHINE.

THE De La Vergne Refrigerating Machine Company, in response to numerous requests and general inquiries from engineers, owners and managers of breweries, cold-storage plants, and artificial ice manufactories, representatives of mechanical and trade journals and others, who desired to inspect a large refrigerating machine being constructed at their works for the Anheuser-Busch Brewing Association, of St. Louis, Mo., issued an invitation to those interested to inspect it on Saturday, March 19, at their works, at the foot of One Hundred and Thirty-eighth Street, New York. A large number of gentlemen availed themselves of this invitation, and inspected the machine and the works in which it was made. It was set up in an annex to the shops at the time it was exhibited, and was all completed. It is said to be the largest refrigerating machine ever built. The gas cylinders are double-acting, 24 in. diameter by 48 in. stroke. The Corliss engine is cross-compound, condensing 600 H.P.; steam cylinders are 32 in. and 64 in. × 48 in. The machine is 28 ft. 6 in. high and occupies floor space 37 ft. 4 in. × 22 ft. 3 in. There are two fly-wheels 14 ft. 8 in. diameter. The crank-shaft is made of best selected horse-shoe scrap iron and is 15½ in. diameter, the crank-cheeks being banded with wrought iron straps 2 in. thick, shrunk in. The shaft weighs 20,820 lbs. The compressor connecting-rods weigh 3,400 lbs. each, and the steam connecting-rods and bearings weighed 4½ tons in the rough. The total weight of the machine in the rough was 390,000 lbs.; the finished weight will approximate 175 tons.

The Corliss engine by which the compressors are driven was built by Hewes & Phillips, of Newark, N. J.

To those unacquainted with the industry of refrigerating machinery, the works of this Company were quite a revelation, as the extent to which this class of machinery is now used is not generally known, and the establishment and the work which has been done there is one of very great interest to all mechanical engineers.

The Company has issued several descriptive catalogues, which are models of their kind. They give a brief history

of the science and development of this class of machinery, a statement of the theory to which it acts, and a very full account of the machinery which this Company manufactures. For clearness of statement, conciseness and general satisfactoriness to readers we know of no other catalogues which are their equal, and it is doubtful whether any literature on the subject is in existence which gives so full an account of the art.

After inspecting the new machine and looking over the works, a liberal collation was set before the visitors in the dining-room connected with the establishment, which is ordinarily used for the convenience of those employed in it. Much admiration was expressed for the design and workmanship of the machine which was exhibited, and all present expressed great pleasure as the result of their visit.

THE CRUISER "ATLANTA."

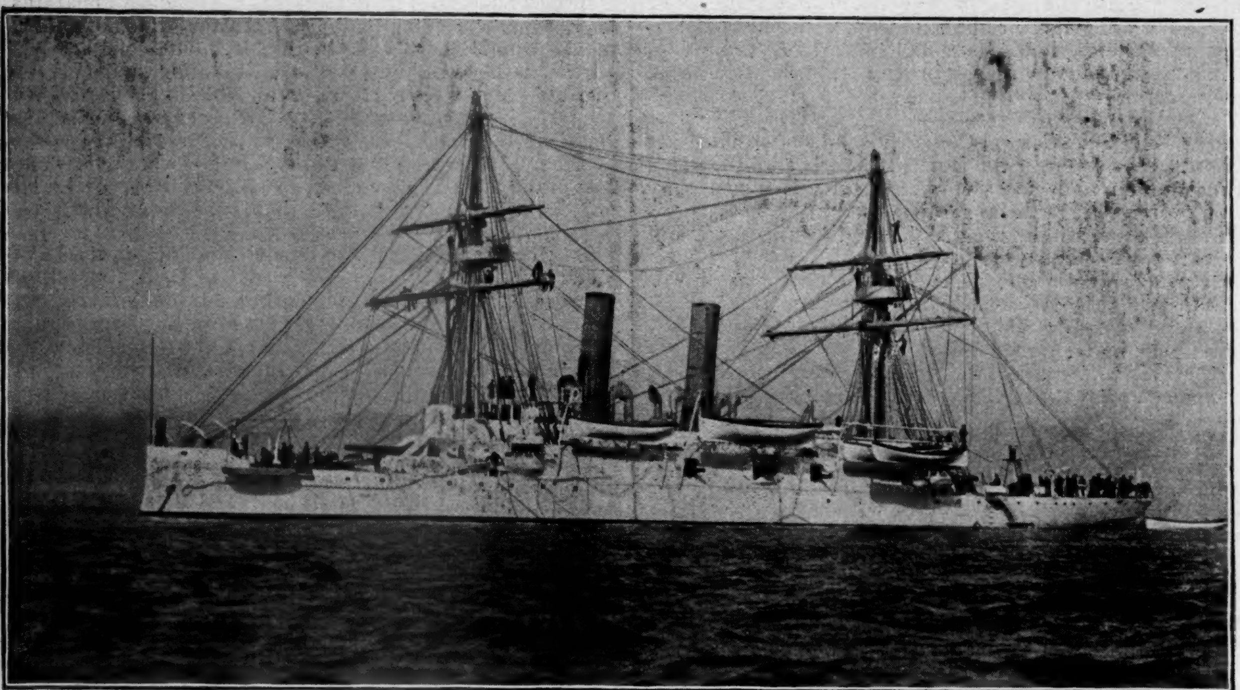
THE accompanying illustration is from an excellent photograph of the cruiser *Atlanta*, of the United States Navy, a vessel which has by this time become familiar to many residents of the Eastern seaboard. The *Atlanta* was one of the first new ships of modern design for the Navy. She was constructed at the Roach Yards, Chester, Pa., and was launched in 1884. She is a steel cruiser, having no armor with the exception of a protective deck extending over the machinery and magazine spaces. She is of the type of vessel having a comparatively low freeboard fore and aft, with a raised central portion, in which most of the armament is carried.

The principal dimensions are: Length over all, 270 ft.; beam, 42 ft.; mean draft, 17 ft.; displacement, 3,190 tons. The battery consists of two 8-in. breech-loading rifles on pivot mounts, one fore and one aft, and of six 6-in. breech-loading rifles carried in broadside in the center house, three on each side. The secondary battery includes four rapid-fire and eight machine guns.

The ship is brig rigged, carrying a small spread of sail; each of the masts is provided with a military top. The pivot guns are protected by heavy steel shields, and the larger rapid-fire guns are mounted in sponsons at the four corners of the central raised deck.

The *Atlanta* has a single screw, which is driven by a compound engine of 3,500 H.P. She has made on trial a speed of 16½ knots an hour. Her bunkers will hold 400 tons of coal on normal draft, and with that supply her cruising range, at 10 knots, is about 5,000 knots.

The *Atlanta* and her sister ship, the *Boston*, have shown themselves to be useful and convenient ships and excellent sea boats. Both have been in commission long enough to ascertain their good and bad qualities thoroughly, and both have been on extended cruises. It must be said that they are useful ships; but had they been built with the added experience gained up to the present time, they would probably have been supplied with twin screws and triple-expansion engines, thereby increasing their speed and efficiency to a considerable degree. As they stand, however, they are excellent ships and creditable representatives of the Navy.



CRUISER "ATLANTA," UNITED STATES NAVY.

SEA-COAST BATTERIES.

BY LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.

THE paper "A Suggestion for Coast Defense" in the JOURNAL for November of last year calls attention to a question not only of vital importance in itself, but, in the opinion of the writer, to some very erroneous ideas abroad regarding both the proper type of a sea-coast work and the *rôle* it is to play in the plan of coast defense.

The primary object of a sea-coast work is to prevent the entrance of an enemy's ships into the harbor or roadstead it guards, as well as a sufficiently near approach to shell the city, dock-yards, etc., behind it. Secondarily, it should provide for the protection of the mine-field, which we may always suppose to be present. It may safely be assumed that in future an assault upon a permanent sea-coast work from the sea, by troops landed from boats, will rarely or never be attempted, and that no special provision to guard against such an attack need be provided. It may also be assumed that if the fire of such a work can be sufficiently controlled to permit the clearing of the mine-field, the forcing of a passage by a fleet will be possible. Upon the ability of the fort to maintain an effective volume of fire will depend the value of this line of defense.

It may safely be added that any scheme that proposes to openly expose guns to the fire of the accurate modern high-power rifle will be to invite disaster, and is not to be considered. All authorities now agree in the statement that either the guns must be protected where they stand,

or else must be so mounted that they may be removed from direct fire and the danger of being dismounted except in the brief interval of time required to point and fire them. The removal of the sky-line, as suggested in the article referred to, by the erection of an immense parapet of earth behind the guns, would, with the present means of accurate aiming, only slightly diminish this danger. If we accept General Froloff's rule that the penetration of a projectile into sand, and into a mixture of sand, clay and vegetable mold, free from stone, to be one caliber for every 60 and 40 ft. of striking velocity respectively, it can easily be seen that to provide cover against a 16-in. projectile moving at the moderate velocity of 1,800 foot-seconds would require to construct upon the plan proposed an enormous amount of labor and material. But any thickness of parapet may be granted, and we are still as far from a safe solution of the problem of defending a harbor as before, so long as our guns are exposed to an enemy's direct fire.

In the United States the men who man the batteries and fight the guns have little or nothing to say during the work of preparation. The engineer plans the work, the ordnance officer the gun and its carriage, and when their joint labor is completed it is turned over to the artilleryman, who must stand or fall according as the means and material put into his hands is adequate to its purpose or otherwise. To-day we are committed to the open barbette battery and the disappearing gun-carriage, and the whole question turns upon the point as to whether the disappearing carriage secures for the gun that amount of protection and safety necessary to its efficient service. The writer believes that it does not, and that unless the relative powers of the attack and defense, under present conditions, are wholly misunderstood, the statement will hold that to match open batteries of any kind (for guns) against a fleet provided with a modern armament is certain to invite disaster.

The persistency with which the military engineer clings to the barbette battery is difficult to understand. In 1887, the year after the Fortification Board made its report, in which it recommended, in a general way, armored works in connection with barbette batteries for coast defense, we find in the report of the Chief of Engineers recommendations for the following year, covering the whole coast-line of the United States. These in the aggregate were to be 13 mortar batteries, 30 barbette batteries, the guns on disappearing carriages, and one barbette battery with the guns mounted upon a lift, and fairly ignoring the suggestion that armored batteries were necessary. Two years later we find there has been a change of opinion sufficient to allow works of this kind to bring up the rear of the list in a scheme for coast protection ; but it is followed by the statement, in substance, that barbette guns mounted upon disappearing carriages are all that we need concern ourselves with at present. Perhaps this persistency can best be explained by that same spirit of conservatism which prompted the military engineer to go on, up to the middle of the nineteenth century, gravely building in sea-coast fortifications draw-bridge, portcullis, machicoulis, and other like architectural frills, which had their birth in the childhood of the engineering art, and ceased to have practical value with the introduction of efficient projectile arms.

As showing the attitude of the Chief of Engineers and the Board of Engineers of the Army toward this question of gun protection, and of dependence upon mortars, from the report of the Chief of Engineers for 1887, we quote as follows, wherein in replying to the argument that the question of coast-defense should be delayed until the question of the character of the armor to be used was settled, he says :

> But the facts will not warrant this conclusion, as more than nine-tenths of the armament recommended for our sea-coasts is not to be mounted behind iron protections, but in rear of earthen covers surmounting and shielding the masonry magazines, bomb-proofs, and store-rooms. Particularly is this true of the rifled mortars, which must hereafter play an important part in the defense of our channels and fairways. . . . Neither is armor required for guns mounted on lifts or disappearing carriages. . . .

In the report of the Board of Engineers of the same year, in speaking of mortar batteries, we find the following :

> No armor is now or ever will be required for such batteries. Mortars constitute more than half the total armament proposed for the defense of our sea-coasts.

In the absence of the demonstration afforded by actual warfare under present conditions, any discussion of a question of this kind must be based upon what has been done in the past under circumstances as nearly analogous as possible, and upon what we may suppose will be the behavior of our new guns and projectiles when brought to the test of actual service.

The only examples at hand are those afforded by the Civil War, and later, the bombardment of Alexandria. While none of these represent fully the conditions under which future engagements between ships and forts will take place, they do represent them approximately, and, we believe, fully sustain the statement that unprotected guns can never successfully withstand even ordinary shell fire, to say nothing of shrapnel fire, or that from machine and rapid-fire guns.

The first in point of time was the capture of the Confederate works in Port Royal Harbor, on November, 1861. Fort Walker, the principal work, mounted about 20 guns, ranging from 32-pdrs. to 10-in. columbiads, 13 of which bore upon the channel. The Federal fleet numbered 17 vessels, 6 of which were improvised gun-boats. Their armament was made up largely of shell-guns from 8 to 11-in. caliber. The ships remained under way, passing and repassing the forts at distances varying from one mile to half that range. At the end of five hours the works were silenced and abandoned. At Fort Walker 10 out of its 13 channel guns were disabled or dismounted. A Confederate eye-witness thus describes the effect of the fire of the fleet : "The heavy shell fell fast within the earthworks, burying themselves and exploding, throwing sand into the guns, covering platforms and gun-traverses with sand, and disturbing much the accuracy of aim and rapidity of fire of our gunners."

At Fort Sumter, when the fleet and batteries opened on August, 1863, there were mounted 20 guns in barbette. The first day's fire dismounted or disabled a large number ; at the end of the third day not one remained serviceable. Fort Wagner, which was as strong an earthwork as more than two years of well-directed and unstinted labor could make it, mounted 17 barbette guns. In the attack of July 18th, 1863, it was completely silenced, and from that time on until its final abandonment, in September, the work was under complete control of the Federal fleet, which could at any time silence its few remaining guns and drive its garrison to the bomb-proofs. Fort Fisher was even a stronger work than Fort Wagner. In the four years the Confederate engineers had learned many practical lessons in the art of building earthworks, and Fort Fisher may be called their masterpiece. Its parapet averaged 20 ft. in height and 25 ft. in thickness, with traverses between each gun 10 ft. higher than the parapet, and from 8 to 12 ft. thick on top. Its armament consisted of about 40 pieces of heavy caliber about evenly divided between the sea and land fronts. In the first attack, at the time of Butler's expedition, in December, 1864, the fire of the fort was practically under control from the time the fleet had gotten into position and obtained the range, following which the garrison were driven from their guns and huddled into the bomb-proofs. Nine guns were dismounted during this attack, which failed simply because the commander of the land force declined to make an assault. The second attack, at the time of the Terry expedition, three weeks later, was even a more brilliant display of thoroughly good work on the part of the Navy than the first had been. The defense was more vigorous at first, but in the end the gunners were driven from their guns, many guns were dismounted, and the work completely dominated by the fire of the fleet.

The attack on Alexandria affords an example approaching much nearer the future conditions of attack than any of our own war. All the guns used upon the ships, and about half of those in actual use upon shore, were Armstrong rifles, with ammunition—for the shore batteries at least—in unlimited quantity. With the exception of Fort

Pharos, all the guns on shore were in open batteries, the parapets (sand) of which in most cases had been greatly strengthened. Thirty-five rifles and about 75 smooth-bores were actually manned and fired by the Egyptians. The rifles were all in embrasures, and so were much better protected than if mounted in barbette. Admiral Seymour brought against these batteries 8 armored vessels and 5 wooden gun-boats. Before the end of a 10 hours' bombardment, which took place at distances varying from 1,500 to 4,000 yards, the gunners were driven from their guns, the batteries silenced, and 10 of the rifles and 20 of the smooth-bore guns dismounted or disabled.

To fully understand the bearing of these examples upon the point at issue—the possibility, or rather the impossibility of efficiently serving open batteries under present conditions—it must be borne in mind (1) that in no case was the defensive power of the earth parapets injured to an extent that a few hours' work would not have restored them; (2) that the armament in each case was, in great measure, rendered unserviceable permanently or for a considerable length of time, the gunners being driven from their guns, and the batteries for the time being silenced; (3) that in each case the defense was stubborn and the gunnery by no means to be despised; and (4) that, except to a limited extent at Alexandria, this was accomplished with common-shell fire.

(TO BE CONCLUDED.)

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS.

XXVI.—HOW TO MAKE SPECIFICATIONS.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(*Continued from page* 89.)

IN the course of the articles of this series which have preceded the present one, frequent reference has been made to specifications, to limits of specifications, to revision of specifications, and indeed copies of the 26 or 28 specifications for materials now in force on the Pennsylvania Railroad have been published. It occurs to us that it might not be amiss to say something, growing out of the experience of now some sixteen years, as to the making of these specifications, and accordingly the present article will be devoted to answering the question, "How to Make Specifications."

If we may trust our experience, it is not at all an easy matter to make a specification which will work satisfactorily. Early in our work the making of specifications seemed to be the simplest of all things. All that it was necessary to do, we thought, was to sit down and write what would give a satisfactory material, saying largely what might be regarded as common knowledge; but a long experience has convinced us that such a specification is practically not worth the paper it is written on, and indeed is more of an annoyance than a benefit or help to both the manufacturer and consumer. As time has progressed more and more work and labor have been put on the making of specifications, until now it is not uncommon or rare for a specification to be under consideration six months, a year, or even longer before it is finally issued.

The reasons for the difficulty in making a satisfactory specification are not very hard to find. In the first place, common knowledge often does not cover sufficient ground for a specification based on it to give the material that is needed. Special investigations are needed many times, and indeed, we may say, are almost always required to decide actually what material is wanted in any particular branch of the service. This point will be taken up a little later, and indeed, as will appear further on, the finding out of what is wanted is not at all the simplest part of the work of making a specification. In the second place, specifications are difficult to make because the different parties who are to use the material in the service have quite varying ideas as to what materials should be used, and also have quite varying conditions to meet, so that a material that gives perfect satisfaction in the hands of certain parties and under certain conditions of the service may not give satisfaction at all in the hands of other parties and under different conditions of the service. It is not at all strange, in our experience, to have the same material praised and blamed from different parts of the service. A third reason why the making of a specification is difficult, is because those who are to furnish the materials have different ideas as to what is the most desirable material, and also have different facilities resulting in different costs of manufacture. There is, therefore, a state of affairs among the producers all tending to break down, to interfere with, or to complain of the requirements of the specifications. To meet these complaints, even when they are just, requires no small amount of work. Still another difficulty is that a successful specification must enable the material to be obtained in such a way that it can be tested, and if unsatisfactory returned to the makers, or otherwise disposed of without introducing too great delays in the service or too great expense. This point will hardly be appreciated by those who have not had practical experience in the working of specifications from day to day. Many times in the course of our work we have not put into our specifications desirable clauses or certain tests simply because the introduction of these clauses or tests, while they would secure a better material, would make the specifications unworkable on account of the difficulty of enforcing these clauses or tests without too great delay or expense to the service. Only those who have had experience can appreciate how powerful this influence is. The problem in making a specification is not simply to put in writing something which will give the best material, but to draw a specification that will give a satisfactory material, and at the same time will work smoothly.

In view of the difficulties above mentioned, it is perhaps not strange that we should claim that the making of specifications is not at all an easy matter, and we are confident the experience of all those who are actually engaged in their enforcement from day to day will confirm our view of the case.

It is well known by those who are informed, that there is considerable complaint among manufacturers of what they believe to be unnecessary annoyance and interference with their works and processes, due to specifications, and to such an extent has this matter developed, that at a recent meeting of the American Institute of Mining Engineers the manufacturers actually brought forward the question of trying to completely break down specifications. To our minds, while the remedy proposed by the manufacturers—namely, the abolishment of specifications, and trusting to the maker and his reputation for material, could hardly be approved, there is still much to be said in favor of their position. The real difficulty is that specifications are presented to the manufacturers which never ought to be presented. There is little doubt but that there are hosts of foolish specifications prepared without anything like proper consideration of the subject-matter, and also that specifications are very frequently badly drawn. We are confident that much of the friction between the manufacturers and the consumers would be relieved if specifications that are presented to the manufacturers were much more

* These articles contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July and August numbers, on How to Design a Paint; No. XX, in the September number, on Disinfectants; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative; No. XXIII, in the November and December numbers, on Soap; No. XXIV, in the January, 1892, number, on Steel for Springs; No. XXV, in the February number, on Bearing Metals.

carefully drawn. As already hinted at two or three times in what has preceded, as time progresses we are continually using more and more care, and putting more and more study on our specifications before they are issued.

Perhaps it will help us a little in the further consideration of this question to define what we understand by a specification. In its broadest sense, we cannot help thinking that a specification is an attempt on the part of the consumer to tell the manufacturer what he wants. This covers by far the largest portion of a specification. Also, in so far as specifications give limits and methods of testing, they are really in the nature of an agreement between the two parties, having a binding influence upon both. The above view is perhaps somewhat different from the ordinary one. A specification is usually regarded as a means of protecting the consumer, and as something which the producer takes, as he does a dose of medicine, not willingly, but because he must. Our experience and view in regard to specifications that are drawn in such a way as to have unnecessarily objectionable features is, that they are inefficient and, from the nature of the case, cannot be enforced satisfactorily. We accordingly prefer to take the higher ground—namely, that the producer wants to supply what the consumer needs, and that the specification is an effort on the part of the consumer to tell the manufacturer what he wants, and also a mutual agreement between them as to what the material shall be. Based on this conception, we will try to tell in what follows our ideas of how a specification shall be drawn.

First, then, the specifications being an attempt on the part of the consumer to tell the producer what he wants, it is obvious the consumer must know what he wants. How, then, shall the consumer get this information? As already stated, if we may trust our experience, this is no simple matter, and is sufficient reason for consuming considerable time and exercising great care in the preparation of specifications. In general, it may be stated, we think, the best source of information as to what a user wants is the service. That is to say, if you want to know what kind of material you should buy, ask the service. It is obvious this is the court of last resort, and it is consequently the best place to go for information. Our usual practice when we start in to make a specification is to ask, What does the service teach us as to what kind of materials give us the best results?. Sometimes in getting this information we collect a large number of worn-out articles, which have given long life and good service, and an equal number, if possible, which have given short life and poor service. Careful examinations are then made of both these lots of samples. To give an illustration, in the case of fire-box steel, not less than 30 worn out fire-boxes were tested physically and analyzed carefully. The results of all these tests being gotten together, the question is, What do these tests teach us as to what gives the best results in service? It is obvious, if the number of samples is sufficiently great, and the teaching from them sufficiently free from contradictory results, that it is possible in this way to get very satisfactory indications, and indeed sometimes positive limitations to be used in making specifications. Such questioning of the service as is outlined above has been made use of in the preparation of quite a number of our specifications, which have already been published, and is constantly being made use of more and more. It will be readily understood that such investigations take time. A single example of good and bad will hardly satisfy, and it takes time to collect together a number of samples which have given good and bad service. Sometimes, likewise, it is difficult to get samples which will compare with each other. The long service of one sample may be due to certain favoring conditions, and the short service of another sample may be due to certain adverse conditions. Theoretically, it would seem as though an investigation carried through a sufficiently large number of samples of good and bad ought to be final authority on what the service teaches; but owing to the uncertainties just mentioned, we are hardly inclined to think that it is quite sufficient to follow blindly what seem to be the teachings of samples from service. We often get strong indications from such examinations; or, in other words, we frequently develop from such examinations a working hypothesis, but it is rare that we simply take alone the results of examinations of good and bad material from the service as final. We always like, however, to start a specification with the examination of materials from service.

It often happens, however, that we cannot get a sufficient number of samples of material that have given good and bad service as readily as we can make a positive experiment, and accordingly we frequently obtain material and put it into service, keeping watch of it to see how it behaves, or in other ways make a positive direct test. We have done a good deal of this work in regard to bearing metals, and also a great deal in regard to the various mixtures of oils to be used for burning and lubrication; also somewhat in regard to materials and proportions to be used in paints. Indications obtained from positive experiments, however, are sometimes misleading, unless great care is taken. Materials that will give perfectly satisfactory results at Altoona will not give perfectly satisfactory results at Wilmington. Moreover, there is always a personal element more or less strong in the use of materials, so that a material in certain hands may give satisfactory results, while in certain other hands it may not; so that we are actually inclined, strange as it may seem, to distrust the results of positive experiments, although the experiments are made by ourselves. On the other hand, the results of positive experiments do give strong indications, and sometimes enable us to set limits which can be wisely adhered to.

These two sources of information—namely, the teachings of good and poor materials taken from the service and actual experiments, as already stated, do not cover the ground completely. Of course, the material must work satisfactorily in the hands of those who are to use it before it goes into the service, and accordingly this source of information is made use of. Consultation with the foremen of the various shops who must use the materials sometimes direct experiments under their supervision, suggested either by themselves or ourselves, and the behavior of the different kinds of materials under these various tests throw much light on the subject. Upon this point of consultation with those who must use the material, we would like to say that, as a matter of policy in the preparation of specifications, it is extremely wise, and it is also wise to make the consultation as broad as possible—that is, do not try to get all your information as to the practical working of materials from one foreman. Comparison of views and comparison of experience from the different foremen throw much light on the subject. Moreover, if those who must use the material are consulted in the preparation of the specifications, they will, when the specifications are finally issued, be much more kindly received and more readily given a helping hand than if the specifications are prepared without their having any voice in the matter.

There is still another source of information which should not be disregarded in the making of specifications, and this is a careful examination and investigation of every piece of material that fails in the service. This is especially true of the breakage of parts made of iron or steel. We have gathered very much valuable information to be embodied in our specifications from this source, and indeed the examination of material that gives short life, or that fails, or that does not work satisfactorily is very often the starting point of the specifications. Something occurs in service that is a little abnormal; a study is made and information gathered. Possibly the same thing is repeated at another portion of the road within three months. Another investigation is made, and possibly the teaching may be the same, or it may throw additional light on the cause of the failure, and so on, until perhaps a dozen cases have occurred. If the teaching is plain enough on the first investigation to cause a change in practice, this is at once made use of, and the subject is held under advisement, for the accumulation of further information which shall lead to positive specifications.

Still another source of information which may be made use of in the preparation of many specifications is to examine the materials that the market affords. Manufacturers of the kind of material in question are asked by the Purchasing Agent to send to the Laboratory a sufficient sam-

ple of such material as they can furnish, and furnish regularly and satisfactorily. After these materials are received they are carefully subjected to analysis, or physical test, as the case may be, and the results tabulated and studied. This gives the man who is to write the specifications a knowledge of what actually is being done or can be done in the market. This source of information, however, is not wholly reliable, and if in making specifications one follows the teachings of such procedure as is outlined above, he will not infrequently run across difficulties later on. The reason for this is that manufacturers are inclined to put their best foot forward, and consequently send for examination a little better material than they can make regularly. It is not uncommon to find that we have placed limitations in specifications, which limitations were dictated by the analyses of the material that the parties have furnished themselves, and yet when we come to get shipments, the material will not pass the requirements. So much is this the case, that we have sometimes had to modify our specifications later on. This peculiarity, if we are rightly informed, agrees with the experience of other parties. Many of the Government specifications, based on correspondence with the steel manufacturers, have run across the same difficulty, because the manufacturers, in competition with each other, stated a little more than they could regularly and uniformly perform. Looked at in this light, of course it is the manufacturers themselves who are to blame for harassing specifications.

Another source of information, and one frequently made use of before the specification is put in writing, is to visit the various works where the materials in question are made. It is obvious that the man who draws the specification, in order to make it work successfully and smoothly, must be able to do justice both to the service, where the material is to be used, and also to those who are to make the material, and it not infrequently happens that by an inspection of the materials used in the manufacture and the processes used, and by consultation with those who make the materials, he gets such information as enables him to avoid putting into the specifications requirements which are unwise. We are very strongly of the opinion that the man who attempts to write a specification without any knowledge of the processes by which the material is made will make a serious blunder. The more intimate the knowledge of the process, the more wisely the specifications will be drawn.

We conclude, then, that for the purpose of getting the information necessary to make a specification, the following sources are all available—namely, *first*, study of good and bad materials which have given service; *second*, direct experiment on materials in service; *third*, consultation with those who must use the materials in service; *fourth*, examination of materials that fail in service; *fifth*, examination and test of materials from different manufacturers, and, *sixth*, visits to and study at the works where the materials are made.

It will be observed that we have given above practically six different sources of information, all of which should or may be studied before one sits down to write a specification. It is perhaps not too much to say that in most of the specifications in use on the Pennsylvania Railroad information has been accumulated from almost all of the above sources before the specifications were written out. Sometimes, according to the circumstances of the case, one source has thrown more light on the subject than another, and sometimes the necessity for action in the matter of securing better materials than we were actually receiving has been so great that we could only obtain information from one or two of the sources before putting out a preliminary specification. But we cannot but think that it is extremely desirable to have each of these sources of information probed as far as possible before the specifications are made. The more care and study there is expended in collecting information before the specification is written, the more likely the specification is to work smoothly after it is written.

Let us suppose now that sufficient information has been obtained from the different sources, so that it is deemed advisable to embody it in the form of specifications; the person who is to do the work gets the information together, sifts it, and gets the teaching from each point, and sits down and puts in writing the proposed specification, embodying all the information as best he can. It is our practice in doing this to give a pattern, or practically describe in brief the material desired. Following this are usually discussions of the methods of selecting the sample, methods of testing, under what regulations the material will be bought, and finally the limitations are given upon which the materials will not be accepted. This information having been drawn up, it is put in print in proof form, and copies are sent to the various officers of the road, who are most closely interested in the use of the material, and also to the Purchasing Agents, with the request to the latter that they distribute the proofs to those from whom they desire to purchase this material, and ask for their criticism. This method of consulting the manufacturers who are to furnish the material is entirely characteristic of all our later specifications, and we feel that it is essential.

This leads us to the second clause in our definition of specifications—namely, that, assuming that the manufacturers desire to furnish what the consumer wants, the specification is really in the nature of an agreement between them, and consequently the producer has a perfect right to be consulted in the making of the specification. Moreover, the knowledge which the producer has of the capabilities of his works, and of what the various processes will yield, is necessarily more intimate and valuable than can be obtained by the person who writes the specification, unless the latter happens to have especial experience in the manufacture of that kind of material, so that the consumer is really shutting out a valuable source of knowledge unless he consults the manufacturers. It is, of course, fair to say that many manufacturers are inclined to bend the specifications to suit their individual circumstances, and we have had very many amusing criticisms and suggested modifications of our specifications sent us in reply to our request for suggestions. On the other hand, we have no hesitancy and no embarrassment in saying that many of the limitations and conditions of our specifications have been suggested by the criticisms of the manufacturers. Some of the limits, and, indeed, the wording in some cases have been taken from the criticisms of the manufacturers on our first draft in proof form.

There is another phase of this case—namely, that if the manufacturers are consulted beforehand in the making of the specifications, they are well informed as to what the demands and growth of knowledge from the consumer's standpoint are going to require of them. Still further, they are conciliated, and they are much better prepared to give the specification a kindly welcome when it is issued than if a full-fledged specification is presented to them that emanates from the brain of some, perhaps, a little too over-confident person. If we may judge from our experience, it is a foolish man who attempts to issue a specification for any kind of material without consulting those who are to make that material for him.

The criticisms from the manufacturers and from the various officers above referred to having been received, these are all sifted, and such modifications in the original draft as seem wise are introduced. It is fair to say that it is not possible always to follow all the suggestions of the manufacturers, and we have found quite to our gratification that the criticisms of the manufacturers were a pretty good antidote to each other. Where they all agree upon a point, it is usually wise to follow their suggestion. Where some are on one side and some on another on a disputed point, you are fairly safe in following your judgment between the two.

While this criticism and discussion is going on, it is usually our custom to have sent to the Laboratory samples from the shipments of the material under discussion, and examine these in the light of the proposed specifications. In this way we accumulate a certain amount of information that we can get in no other way. In reality, we assume, for the purpose of the Laboratory work, that the specification is in force, and examine all the shipments of the material that are received, just the same as though they were in force, the only difference being that if we find the shipments do not conform to the specifications, we do not reject them, because they were not bought in accordance

with specifications. We were led to this method by finding that usually, after all our care in making specifications, something would occur, within the first six months of their actual working, which would demand a modification, and so we utilize all the time we can in getting experience with the specifications before they are issued. Moreover, the manufacturers of many commercial products are frequently not fully informed of their own product, and the information collected in this way from the examination of shipments of their material is often sent them for their guidance and knowledge.

The criticisms all being in, and experience being obtained, the specifications are finally issued. It is perhaps not too much to say that in important specifications, with all our care, we still have to revise from time to time. Progress in knowledge, changes in our practices, and many times changes in methods of manufacture lead to these modifications. It is no small work to keep up with the development and changes in the methods of manufacture for the various articles for which we now have specifications. Again, each manufacturer is constantly trying to make a material which will meet the limits of the specifications at less cost to himself, and it not infrequently happens that this leads to the production of a material which is inferior. The specifications must therefore be modified to meet this peculiarity.

We are quite well aware that it is probable the criticism will be made by many engineers, that if our method of making specifications were followed, there would be no specifications, as many times it would be impossible to have such facilities and access to sources of information as will enable study enough to be put upon the subject to make a specification wisely. It will undoubtedly be urged that many specifications must necessarily be made from common knowledge, and also that in many cases the consumer knows without special study what he wants, which is simply the best which can be made of the kind.

In reply to this we would say that we are quite familiar with the emergencies which are constantly occurring, and which lead to action on insufficient knowledge. No class of men in the community are meeting emergencies more constantly than railroad men, and it not infrequently happens in our experience that we are called upon to make specifications without having given the matter sufficient study. In such cases, recognizing that our knowledge is limited, we have thus far drawn specifications so as to overcome the difficulty which gave rise to the necessity for action, but at the same time in such a way as not to cause hardship to those who must furnish the material. In other words, we cannot but conceive it wise, if we do not have positive knowledge, which leads to a rigid demand on the manufacturers, it is much better to make the demand one that can be fairly easily filled. We are perfectly rigid and unyielding where the service furnishes the information leading us to take such a position, but where it is a question of judgment, where limitations must be placed on general information, we submit that it is wise simply to make the limits such that they will not cause unnecessary annoyance to those who are to fill the specifications. To put the whole matter in a single sentence, we cannot but feel that in many cases a specification is made a place to show how much the man who draws it knows. We also feel that this is certainly unwise, and that the interests of the service will be equally well protected without many of the narrow limitations and tortuous tests which are characteristic of some of the specifications which have come under our eyes. A mild specification rigidly enforced is infinitely better than a rigid specification, with constant jangling and constant yielding by the inspector to allow materials to pass.

In the next article we will try to say something about Sampling, and the Enforcement of Specifications.

(TO BE CONTINUED.)

COLUMBIAN EXPOSITION NOTES.

It is announced that the Pennsylvania Railroad Company will make a fine exhibit in the Transportation Department, and that the New York Central & Hudson River and its allied companies will also make a large exhibit. Both of these will be planned and arranged to illustrate American railroad practice on the most improved lines; they will also be historical in their nature, and will show the growth of the several systems. Mr. T. N. Ely has charge of the preparation of the Pennsylvania Railroad exhibit.

Seven of the World's Fair buildings are now so far advanced that they are fast assuming the appearance of finished structures. The rough carpentry work on them is practically done, and the ornamental and finishing work is in progress. These buildings are the Woman's, Horticulture, Transportation, Mines, Administration, Forestry and Fisheries. Five more—the Government, Fine Arts, Agriculture, Dairy and Illinois State—are erected to the roof lines. The Electricity, Manufactures and Machinery buildings are being advanced rapidly.

Plaster work on the Mines Building is finished; the gallery railings are nearly completed, and wire work is being set. Staff work on the south end of the building is nearly finished. All of the carpentry work and iron work on the Transportation Building is in place except the central elevator tower.

All of the trusses of the Electricity Building, with the exception of the central diagonal trusses, are in position.

On the Administration Building 160,000 ft. of lumber and 20,000 lbs. of iron have been added during the week. Roofers are working on the northeast and northwest pavilions.

On the big Manufactures Building the record shows a total of 9,797,152 ft. of lumber used, in addition to which has been received 444,000 ft. of lumber and 168,000 lbs. of carpenters' iron. The great traveler which is to be used for hoisting the immense girders spanning the central court is already 120 ft. high, and is yet less than half completed. When completed it will be used for putting in place the largest trusses ever made for architectural purposes, spanning 368 ft. and rising to a height of 211 ft.

The iron work for the dome of the Fisheries Building is complete, and staff work is nearly finished in both annexes.

Ornamental staff work is being rapidly placed on the west end of the Agricultural Building, and the roof trusses over the nave and transept are in position. The iron for the entire building is on the ground, and the walls for the south half are about ready for the roof iron.

Work on Machinery Hall has been retarded, owing to non-delivery of iron, but the total amount of lumber placed foots up 30,000 ft., and iron, 102,000 lbs. Most of the carpentry work has been to frame the annex superstructure. The second of the large arches is now in position.

Work on the Dairy Building is nearly finished, also on the Forestry Building. The latter is being temporarily used as a shop for the molders who are casting the big figures and groups for the Administration Building.

SOME NEW COMPOUND LOCOMOTIVES.

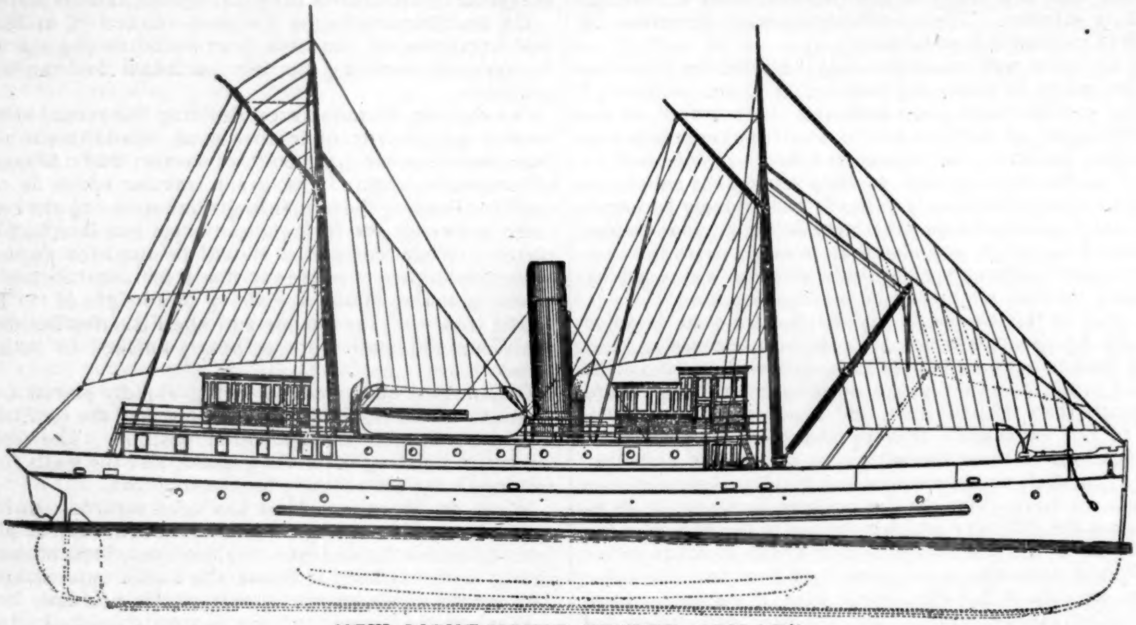
A COMPOUND consolidation locomotive of the pattern devised by Mr. F. W. Johnstone, of the Mexican Central Railroad, was described in our columns some time ago. Mr. Johnstone has now completed plans for a double-bogie compound engine, and several locomotives of this pattern are to be built for his road. The engines have two boilers placed end to end, the fire-boxes adjoining each other and the fire-doors being at the side. The boiler and the cylinders will be carried on a rigid frame, but the running gear will be arranged in two groups, each group forming an independent truck. The plan is in outward appearance somewhat similar to the Fairlie double-bogie engine, which attracted considerable attention some years ago, but with the essential difference that in the Fairlie system the cylinders were carried on the truck frames, while in Mr. Johnstone's plan the cylinders are secured to the boilers and to the main engine frame. The piston-rods of the engine work on the upper ends of levers carried in bearings on the main frame, and the connecting-rods are attached to the lower end of these levers. Each of the truck frames carries three pairs of coupled driving-wheels and a two-wheeled truck, the radius-bar of this truck being pivoted to the front of the truck frame. The

engine will have no tender, the water being carried in saddle tanks. The cylinders are of the type patented by Mr. Johnstone, the high-pressure cylinder being placed inside the low-pressure, the latter consisting of a ring or annular cylinder around the high-pressure.

The boiler, or rather boilers, of these engines will be 52 in. in diameter, and will have 201 tubes 2 in. in diameter and 15 ft. 9 in. long. The fire-boxes will be of the Belpaire type, 56 in. long and 56 in. wide inside. As they are placed between the trucks, opportunity is given to make them of unusual width. The driving-wheels are 48 in. in diameter and the truck wheels 28 in. The trucks are of the swing-bolster pattern. The high-pressure cylinders are 13 in. in diameter and the low-pressure 28 in. outside diameter. The ratio of the cylinders is about 1 : 2.8. The valve motion is outside, and is worked directly from the crosshead, no links or eccentrics being used.

The tanks will have a capacity of 3,000 galls., and the coal bunkers, which are placed at the side of the engine, will hold about 5 tons of coal. The total weight of these engines in working order will be about 230,000 lbs., of which 200,000 lbs. will be carried upon the driving-wheels.

The peculiar features of these engines are covered by patents issued to Mr. Johnstone; and he claims that they will be well adapted for the difficult mountain service of the Mexican Central and on railroads of the similar class.



NEW LIGHT-HOUSE TENDER "LILAC."

NEW LIGHT-HOUSE TENDERS.

(From the Cleveland *Marine Review*.)

Two light-house tenders, the *Lilac* and *Columbine*, building at the yard of the Globe Iron Works Company, Cleveland, O., to go, respectively, to the First Light-house District with headquarters at Portland, Me., and the Thirteenth District with headquarters at Portland, Ore., are described in the annual report of the Light-house Board just issued. These boats as they appear on the stocks at the yard of the Globe Company are of great credit to the officers of the Light-house Board, as well as the builders. They are duplicates; and it may be said of them in a general way that the hulls are as fine in appearance as either of the costly steam yachts that left the stocks in Cleveland recently, and their engines are as neatly built as anything ever turned out by the Globe Company. They will prove good specimens on the Atlantic and Pacific coasts of the work of lake ship-builders. Another light-house tender for lake service, the steamer *Amaranth*, is nearing completion at the yard of the Cleveland Ship Building Company, and four others, lightships for the Atlantic coast, are under way at the yard of F. W. Wheeler & Company, West Bay City, so that shortly after the spring opening seven boats will be turned over from lake builders to the Light-house Department, six of them going to the coast.

The engraving shows the general plans of the *Lilac* and *Columbine*. The material is Siemens-Martin mild steel, and the dimensions are: Length over all, 155 ft.; length from inside rudder-post to inside stem, 145 ft.; beam molded, 26 ft. 6 in.; depth of hold from top of beam to top of keel-plate, 15 ft. 2 in.; depth of hold from top of beam to top of double bottom, 12 ft. 4 in.

The vessels are fitted with a double bottom; inside height of this double bottom, in the clear between plates amidship, will be 34 in. The vertical center keel-plate runs from end to end of the vessel, tapered forward and abaft the double bottom, to the height of keelsons at these places; it forms the keelson and extends down to the skin of the vessel for three frame spaces, the floor plates on these frames being cut and securely riveted to the center keel-plate by angles 3 × 3 in. × 6 lbs. The side keelsons or girders also run continuously, the floor plates and brackets between the girders being cut. This double bottom is divided into four separate water-tight and independent compartments, each provided with a sufficient number of manholes properly constructed and so located that access can be had at all times to every compartment for cleaning and other purposes. There are seven water-tight bulkheads dividing the parts of each vessel above and forward, and abaft the double bottom, into eight water-tight compartments. The vessels are built with a flat plate keel in double thicknesses and provided with an extra protective keel, also with one outside bilge keel on each side of the vessel. The vessels are rigged as two-masted schooners, with pole topmasts, gaffs and derrick booms. Each will be supplied with a steam windlass, steam hoisting engine, and the best appliances for handling anchors, buoys, and cargo or any other purpose required by the service. An electric plant for operating a search light and for illuminating all parts of the vessel will also be a feature of importance.

There is for each steamer one right-handed cast-iron screw propeller about 9 ft. 4 in. in diameter and of suitable pitch, driven by an inverted cylinder, surface condensing, fore-and-aft compound engine; the cylinders are 22 and 41 in. in diameter, with a stroke of 30 in. The steam is furnished by two cylindrical single-ended boilers 10 ft. 8 in. in diameter and 10 ft. 9 in. long, each fitted with corrugated furnaces.

In addition to the necessary trials of the machinery at the dock a trial trip is also to be made of about 12 hours' duration, and the engine must develop 600 indicated H.P. when making 110 revolutions per minute, with a coal consumption of 2¼ lbs. per indicated H.P., and steam, per gauge, at 100 lbs. pressure per sq. in.

SOME STANDARD COAL CARS.

THE illustrations herewith show three different styles of coal cars, and are of interest as illustrating the different

Fig. 2.

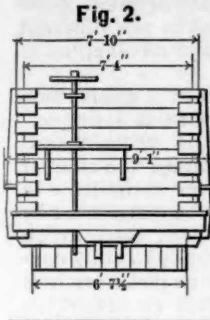
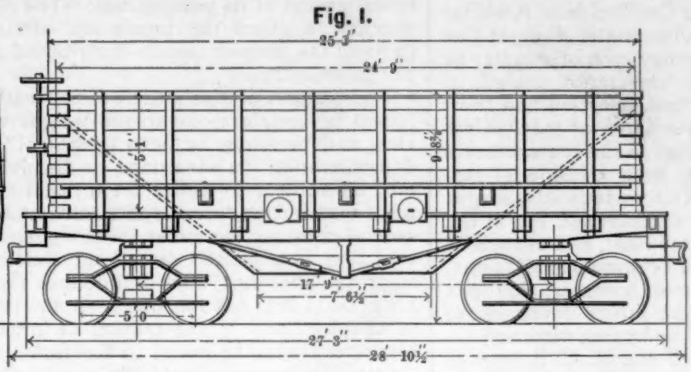


Fig. 1.



types which have been found serviceable in the same traffic.

Figs. 1 and 2 show a side elevation and end view of the standard hopper-gondola in use for coal traffic on the Baltimore & Ohio Railroad. The general dimensions are shown in the engraving: The length of the box inside is 24 ft. 9 in. and the width, 7 ft. 4 in. The hopper has two clear openings, each 35 in. × 76 in. in size. The weight of the car is 29,700 lbs. and its capacity, 60,000 lbs.

Figs. 3, 4 and 5 show an experimental iron coal car built for the same traffic; fig. 3 is a side elevation, fig. 4, an end view, and fig. 5, a half plan. The car frame is of wood and the box of iron, with cylindrical ends. The box is 7 ft. 6 in. wide and 21 ft. 6 in. long; the hopper opening is the full width of the box, and 3 ft. 4 in. long. This car weighs, empty, 26,800 lbs., and has a capacity of 60,000 lbs.

Fig. 5.

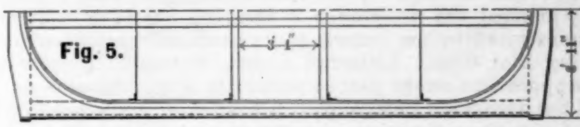


Fig. 4.

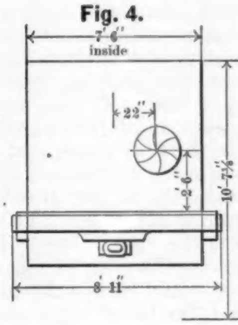


Fig. 3.

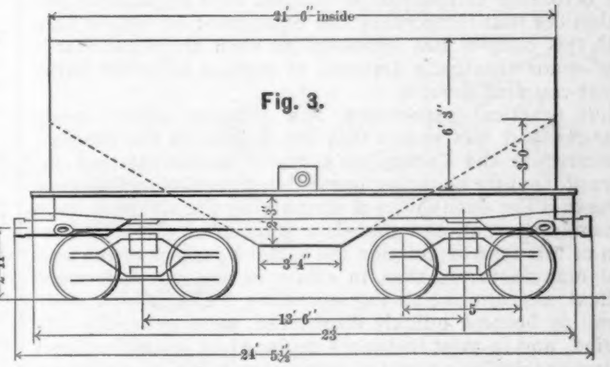


Fig. 7.

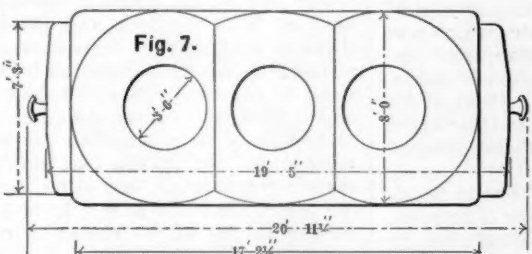


Fig. 8.

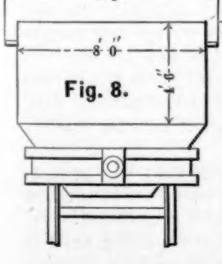
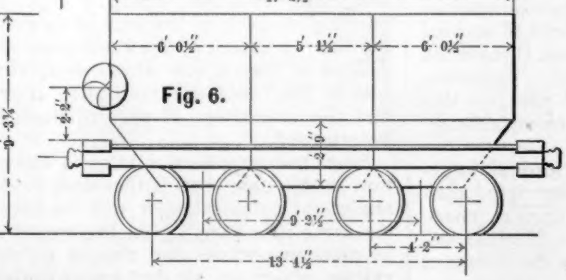


Fig. 6.



Figs. 6, 7 and 8 show the latest improved form of a type of coal car which has been in use on the Baltimore & Ohio for many years, and which is peculiar to that road. It is an iron coal hopper, the box or body being of iron, composed of three intersecting cylinders, and having three hoppers for discharge. The general form and dimensions are so fully shown that little further description is needed. The latest form, shown in the drawings, has a capacity of 40,000 lbs. of coal, and its weight, empty, is 17,050 lbs. It may be said that this type of car has some good points about it which are worth considering.

Figs. 9, 10 and 11 show respectively a side view, an end view and a plan of the standard freight truck in use under the cars shown above. The axles of this truck have 4¼ × 8-in. journals; centers of journals, 6 ft. 3 in. apart. The springs are of the helical type. The axles are spaced 5 ft. between centers, and the wheels are 33 in. in diameter. The truck is of the diamond type; the bolster is composed of three timbers, the middle one being 4½ × 10½ in., the two outer ones, 3½ × 10½ in., the space between each being ¾ in. This form of bolster is not a usual one. This truck is used under several different classes of freight cars.

All these types of cars have done and are still doing excellent service on the road, chiefly in carrying bituminous coal, in which a very large business is done by the line on which they are in use. Each of them has some points of excellence about it.

Fig. 10.

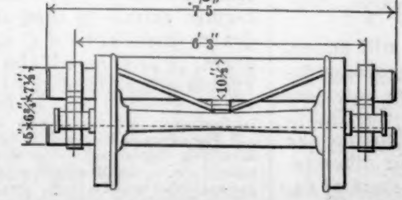


Fig. 11.

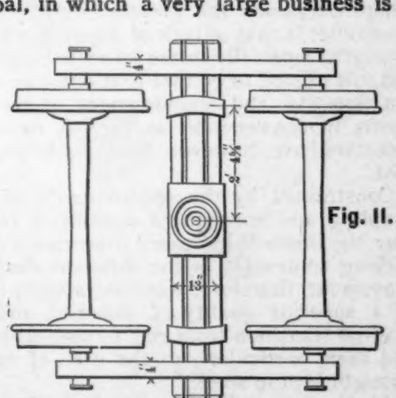
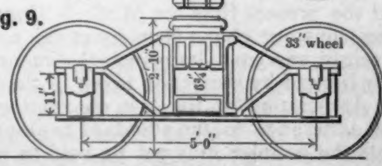


Fig. 9.



A DISCUSSION OF THE POSSIBILITIES OF THE M. C. B. COUPLER.

By Edward P. Eastwick, Jr., C.E.

At the Convention of the Master Car Builders' Association, in 1887, the Committee on Automatic Freight Car Couplers, in recommending the Janney type of coupler to be adopted as the standard of the Association, stated, in substance in its report, that while this selection had been the result of a careful study of the superior mechanical features of the device and its adaption to the requirements of practical service, it was far from being considered perfect in many important details. The various advantages over other types of couplers were enumerated, but at the same time serious defects were pointed out, and especially that of insufficiency of strength, a fault common to all forms. It was the opinion of the Committee, however, that this defect was remediable, and that the future development and perfection of the device should be in that direction.

It is now nearly five years since the M. C. B. type of coupler was adopted by the Association, and that it has fully merited the preference it received has been clearly demonstrated by the record of its practical performance during that time. Although at first met with considerable opposition on the part of advocates of the link-and-pin and the automatic link coupler, it has steadily advanced in the favorable estimation of railroad men in general, and within the past three years the equipment of freight cars with this coupler has increased to such an extent that it now seems eventually destined to replace all other forms of car-coupling devices.

But practical experience has brought about many changes, and has shown that the defects in the coupler, indicated in the Committee's report above referred to, were of a nature requiring immediate attention and prompt remedy. The desirability of simplifying the action at once became apparent, and therefore soon after the introduction of this type of coupler the various designs of the several manufacturers then in existence and use underwent radical alterations; spring operating locks, which were found to become quickly disordered, were generally discarded, and in most instances replaced by a simple direct acting gravity lock; means were also taken to overcome the evil effects of wear and lost motion thereby developed at the lock and pivotal point of the knuckle, which was most disastrous in allowing couplers to come apart, especially in those forms having the shortest arm and consequent greatest leverage acting on the lock. Many of the couplers found insusceptible of improvement in this regard went out of existence and new ones otherwise adapted sprang up in their place.

But in all the most prominent and serious defect developed, and seemingly one inherent in this type of coupler, which occasions the greatest difficulty in attempting to overcome, is that of lack of durability and insufficiency of strength, especially in the knuckle; and indeed so serious has this proved to be that it at one time almost threatened the downfall and abandonment of the type. Improvements in construction as regards remedial effect in this direction have, however, been made to a considerable extent.

Constrained by the requirements of reciprocal intercoupling and consequent conformity to a restricted contour, the limits of increased dimensions were soon reached, varying somewhat in the different devices. Further improvement, therefore, was next sought in the employment of a superior quality of material, and thus followed a gradual transition from cast to malleable or wrought iron, and then, particularly in the case of the knuckles, from wrought iron to steel.

At the present time the M. C. B. Coupler is still undergoing constant changes to meet the severe requirements of freight service. Its principal dimensions are now narrowly limited by the action taken by the Master Car Builders' Association at the last convention in requiring the close adherence to the standard contour, but in other respects the coupler may yet be said to be in a state of development. Whether the necessary and desirable degree of strength has or can be attained in this type of coupler in any of the forms now in use, or is likely to be attained in any further variation, is a question that future experience and time must answer. That it is capable of greater strength and endurance than has yet been reached would seem most probable in view of the results of a scientific investigation of its possibilities. The consideration of the manner in which the forces and strains in the different parts of the coupler may be distributed and modified leads to this conclusion.

The purport of this article is to treat of the strains sustained by couplers of various designs when in active service, and to show by both graphical and mathematical demonstration the advantage or disadvantage the coupler may be subject to under them; moreover to indicate in what manner the forces and strains may be distributed by special construction either for the purpose of equalization or action in a desired direction; and finally to fully consider the effects of wear and deduce the general formulas for same. It is not the intention to reflect on any makes of couplers now in the market or in use, and any resemblance that may be found to the forms herein selected for illustration is purely incidental, as must be the case with all couplers of this type.

The investigation will be confined simply to the determination of the directions and intensities of the forces sustained by a coupler when subjected to both a pulling and buffing force, and will illustrate by diagram the changes which take place in them, resulting from alterations in the relative positions of the lock and pivotal point of the knuckle, the surface for resisting a buffing force in the drawhead, and the lines of action of the pulling and buffing forces. At the same time the incidentally advantageous and injurious effects will be pointed out.

In the first place, that form of M. C. B. Coupler will be considered in which the lock and pivotal point are on the same side of the drawhead, and where also the buffing strain is sustained. The bearing face of the lock is parallel to the center line. This is represented in the accompanying drawing by fig. 1, in which the knuckle is shown as it would be in a closed and locked position in the drawhead, the latter being omitted in the drawing as not being necessary to our present purpose. The knuckle is pivoted at O and the lock is at F. We will presume the pulling force to be acting at Q along the line $L\,L$, which is the center line of the coupler. A force is thereby caused to bear at both the lock and pivotal pin. Assuming that there is no frictional resistance at the lock, which is admissible in this connection, as it in no way deteriorates the value of the deductions to follow, the force caused to act on the lock (and consequently the resistance offered by the lock) will be in a direction perpendicular to its bearing surface, for the reason that in that case it is incapable of resisting a force in any other direction.* Now the pulling force, the resistance offered by the lock, and that by the pivotal pin at the center of revolution of the knuckle are in equilibrium; hence if $F\,A$, perpendicular to the bearing surface of the lock at its center point, represents the line of action of the resistance and intersects the line $L\,L$ at A, then a line drawn from A to O gives the direction of the force and resistance acting at the pivotal pin, and the intensities of each of these forces can be readily determined.

Since the graphical statics is the more easy of application in this case, and is therefore preferable to a laborious analytical calculation, it will be herewith employed. At the same time it will give the means of comparing results by mere inspection and thus of quickly obtaining relative values, which are all that are at present desired.

On the line $L\,L$ lay off $A\,C$ (fig. 1) to any convenient scale, so that it represents the pulling force according to a certain ratio. If then the dotted lines $B\,D$ and $C\,D$ are drawn parallel to $A\,C$ and $A\,B$ respectively, a parallelogram, $A\,B\,C\,D$, will be formed, from which, by the well-known principle of the parallelogram of forces, the forces

* The effect of frictional resistance at the bearing surface of the lock in modifying the intensities and directions of the forces acting at the lock and pivotal pin, as will be subsequently seen, is considerable. But in the present instance the results to be obtained are simply relative, and as the general effect of friction is similar in each case to be taken up it may be entirely neglected, and in no way detracts from the practical value of these results. The effect of friction will, however, be fully explained later on.

acting at the lock and pivotal pin are at once found. Thus the force at the pivotal pin acts along the line *A O* in the direction indicated by the arrow, and its intensity is represented by the line *A D* measured by the same scale adopted for *A C*. In like manner the direction and intensity of the force acting against the lock is given by the line *A B*.

By a similar method, if the buffing force is taken as acting at *Q'* along the line *S S*, the resulting force at the pivotal pin and point of resistance in the drawhead *M* may at once be determined from the parallelogram *Y I N S*, and by modifying the positions of the lock, pivotal point and point of resisting a buffing force in the drawhead, relative to each other and to the lines of action of the pulling and buffing forces, the intensities and directions of the forces produced at these three points may also be determined for different conditions.

Figs. 4, 5, 6 and 7 represent in this respect examples of practical adaptation. In each case *A C* represents an equal pulling force and *S Y* an equal buffing force laid off to the same scale used for fig. 1. The variation in the forces produced are thereby displayed, and comparisons may readily be made by simple inspection.

Referring again to fig. 1, it will be seen that a pulling force, *A C*, induces a force, *A D*, at the pivotal pin, which latter is the greater of the two; that is to say, the lock having its bearing surface parallel to the pulling force is incapable of directly opposing it, but simply acts as a stop to the induced force of leverage in preventing the outward movement of the knuckle and the relative positions of the line of action of the pulling force, the lock and pivotal pin are such that the force is increased at the latter point. As the bearing face of the lock changes in direction so as to incline toward the center line, or line of action of the pulling force, it commences to take a part of that force directly, which increases as the angle approaches 90°. At the same time the portion of the force will also increase as the position of the lock approaches the center line; and if the position of the pivotal pin remains constant, the force to be resisted at this point will proportionately decrease. This will be made clear in the cases immediately to follow.

In fig. 4 is illustrated a coupler in which the lock is exactly central, and the direction of its bearing surface coincides with a radial line drawn from the center of revolution of the knuckle. In this instance the force at the pivotal pin is much less, and the pulling force is more equally distributed to the knuckle and drawhead than in the foregoing example. If the lock remains in the same position

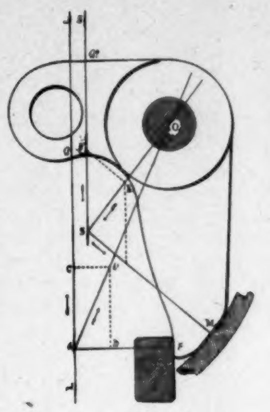


Fig. 1.

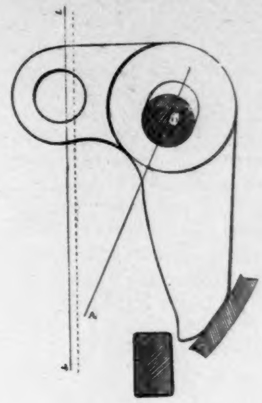


Fig. 2.

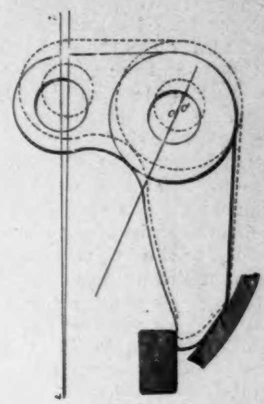


Fig. 3.

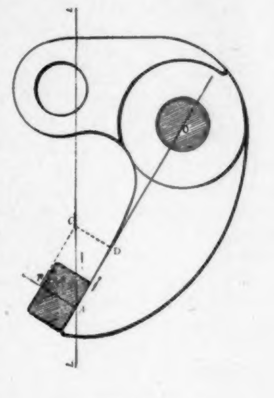


Fig. 4.

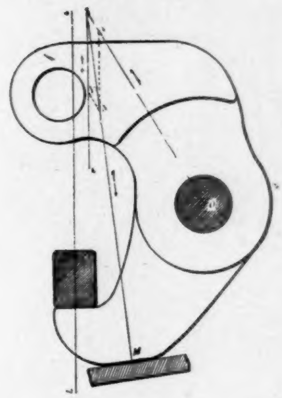


Fig. 5.

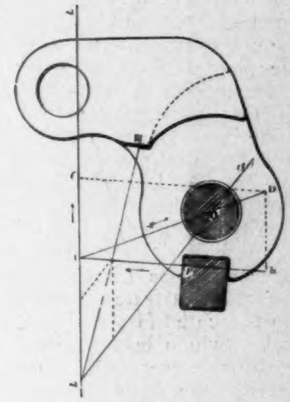


Fig. 6.

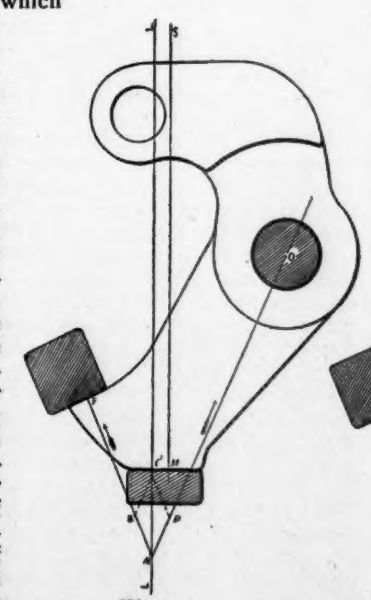


Fig. 7.

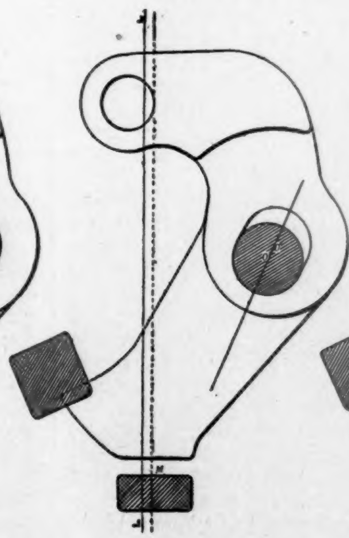


Fig. 8.

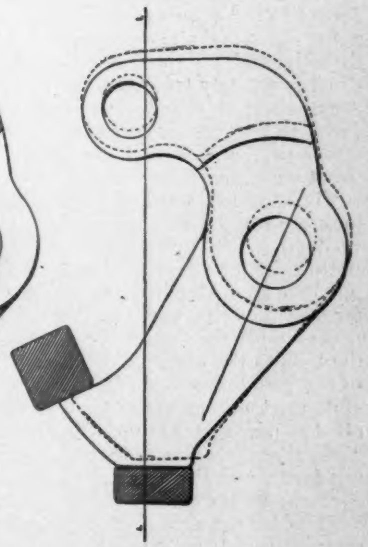


Fig. 9.

on the center line, but the direction of its bearing surface changes so that it becomes at right angles to this line, as shown in fig. 5, there is again a condition which causes a pulling force to be resisted alone at one point. Here the entire pulling force is sustained at the lock, and no force whatsoever acts at the pivotal pin. In fig. 1 the opposite is nearly true, although the lock in this case sustains an indirect force, greater or less, depending upon the distance of the lock from the pivotal pin.

In a coupler designed as indicated in fig. 1, the hinge or pivotal pin of the knuckle must necessarily be located well forward in the drawhead, and as the force bears at this point, the strain at times becomes very great. Even a steady, straight pull equivalent to the ordinary draft power of a locomotive exerts a force against the pivotal pin of not less than 12 tons under the most favorable conditions, and the effect of shock, to which a coupler in use is more or less subjected, is to greatly increase it. The lugs of the drawhead, through which the pivotal pin passes, receive this entire strain, and the hauling consequently takes place wholly at these two points, or, in other words, from only one side of the drawhead. There is thus caused a great strain on this side of the drawhead, and especially on a section—*i.e.*, through the pivotal holes, which in the required constructions adapted to the conditions is the weakest portion of the drawhead, as increased strength by greater dimensions (except in depth) is not attainable under the restrictions of the contour lines required by the M. C. B. Association. The dimensions of the knuckle around the pivotal hole are also correspondingly restricted.

It will very quickly be discovered by any one undertaking the design of an M. C. B. coupler that the positions of the lock and pivotal point are mutually dependent one upon another, and that as the lock is moved over toward the center line and on to the other side of the drawhead, the pivotal point must be brought further back in the drawhead, so that the shank of the knuckle, when open, shall not project too far from the drawhead, and thus become jammed and prevent coupling. On the other hand, if the pivotal pin is moved back farther into the body of the drawhead, the lock must be placed nearer the center line, for otherwise the leverage on the lock would be greatly increased. The effect of this is clearly shown in fig. 6, which represents a design of a coupler at one time extensively used, but which has been abandoned.

Fig. 4 illustrates the construction whereby the pivotal pin is located farther back in the drawhead than in fig. 1, and in which less strain is developed at the pivotal pin. It allows a greater thickness of metal around the pivotal holes of the drawhead and knuckle, and has, therefore, a threefold advantage in securing a much stronger design, while at the same time the pulling force is partially transferred to the center of the drawhead.

In fig. 5, as above stated, a straight pulling force is directly and completely sustained by the lock, and the draft is entirely from this point. This construction, however, while it relieves the pivotal pin and transfers the force to the center of the drawhead, causes an increased strain in the shank of the knuckle, to withstand which a great weight of metal would be required.

Fig. 7 shows another form in which the pivotal pin and lock are respectively on opposite sides of the center or line of draft. The pulling force in this construction acts on both sides of the drawhead, and the distribution is dependent upon the distance which the lock is from the center line and the angle which the bearing face of the lock makes with this line. The pivotal pin is placed back in the lugs to the extreme limit permissible for proper action of the coupler, and there is thus secured the greatest possible thickness of metal for the lugs of the drawhead, the pivotal pin, and around the pivotal hole in the knuckle. This, together with reduced strains produced by the pulling force, constitute great advantages of this construction over any so far considered.

Thus far the action of pulling forces have been chiefly referred to. It is, however, the buffing forces which cause the severest strains to which a coupler of this type is ever subjected, and undoubtedly effects the larger proportion of the breakage which occurs. It is generally a shock, and the most difficult, for the metal to withstand.

Referring again to figs. 1 and 5, it will readily be seen that the strain caused by a buffing force, and sustained by the pivotal pin decreases (*a*) as the angle between the surface of resistance in the drawhead and the line of action of the buffing force becomes greater also; (*b*) as the surface of resistance approaches nearer the line of action of the buffing force, and that it will be a minimum when the center point of the surface of resistance is exactly on the line of action of the buffing force, and the direction of this line is at right angles to the surface. Thus in figs. 1 and 5 the force acting on the pivotal pin is represented by *I S*. The consequent tendency of this force to break off the pivotal lugs of the drawhead is in the former case much greater than in the latter; therefore, considering both effects of the pulling and buffing forces, the construction shown in fig. 4 (the buffing resisting surface being in the same position as in fig. 5) would appear to possess an evident advantage as regards strength and resisting power over either those of figs. 1 or 5.

Proceeding to the case illustrated in fig. 7, we have the lock moved over the center line to the side opposite that in which is located the pivotal pin, and the buffing surface central on the line of buffing force. The parallelogram of forces shows that the sum of the forces sustained by the lock and the pivotal pin is greatly reduced, and that by a proper direction of the bearing surface of the lock these forces may be equalized. The force acting on the lock is no greater than that which occurs in the construction represented by either figs. 1 or 4, and the force on the pivotal pin is much less. The pulling force is, besides, more equally distributed over the knuckle and drawhead, and the *sum* of the forces acting on the lock and pivotal pin is made to very nearly equal the pulling force; that is, *it closely approaches the minimum*, which is only attainable when the locking surface is placed perpendicular to the line of action of the pulling force. But to maintain an equal distribution of force at the same time, at the lock and pivotal pin, this latter condition necessitates the lock and pivotal pin being equally distant from the line of action of the pulling force, and this is impracticable of application. The buffing force is resisted at a surface within the drawhead on the line of action of the force and at right angles thereto, so that, as before explained, no strain is caused at the pivotal pin. Hence the condition of *minimum total* strain on the knuckle and drawhead is here again attained in the case of a buffing force as it was for a pulling force, for it at all times equals and never exceeds the buffing force itself. It is apparent that the necessary form of knuckle may be made to withstand an immense compressive force, and that this quality together with the advantages of increased dimension for the pivotal pin and the reduced strain at the lock and pivotal pin for both buffing and pulling force, especially the former, combine to constitute a construction of superior strength and endurance.

This latter property in its relation to construction it is now proposed to examine.

The durability of a coupler, by which is meant the length of time during which it may be in use without becoming disabled from breakage or wear, is dependent upon two things: first, the material of which the coupler is made, and second, the construction or design.

The selection of a proper material is of the first importance, and is a subject which has been given considerable attention by both manufacturers and users of automatic couplers, but its discussion in reference to any coupler is applicable to all the various types and modifications, and is not within the scope of this article.

Construction in its relation to strength has already been considered, and it now remains to show how construction alone modifies the effects of wear.

Two M. C. B. couplers, when coupled together and locked, cannot come apart in a horizontal direction so long as the lateral movement of the entire coupler or knuckle alone is so limited by the heel of the knuckle of one coupler striking against the guard arm of the other that the coupling faces of the knuckles are kept in contact by a pulling force. If, however, this limit is exceeded, uncoupling takes place.

Now the lateral movement increases with the wear on the heel of the knuckle or guard arm of drawhead or both, and also in proportion as the coupling face of either of the knuckles moves outward from its respective drawhead. But for the same contour lines the effect produced by equal wear on either the knuckle or guard arm is the same in all forms of the M. C. B. coupler. It can not be modified simply by construction; and as it is relative and not actual results which are sought, it will be omitted in the present

discussion.* The outward movement of the coupling face is the result of wear at each or all of three points—viz., the coupling face itself, the bearing face of the lock † and the pivotal pin or bearing. Again the effect of wear at the coupling face of the knuckle is the same in all forms of the stated coupler, and is in no way modified by construction, consequently, for the reason just given, it will also be neglected.

There remains, therefore, for consideration the effect of wear at the lock and the pivotal pin and its bearings, and it will be shown that at either of these points it is directly dependent upon the design or construction of the coupler, and varies in amount and in effect according to the relative positions of the lock, the pivotal point, and the line of action of the pulling force.

The wear at either point is proportional to the force acting at the point and inversely proportional to the wearing surface, and it is in the direction of that force. The effect of wear at either point in all cases is to cause the outward movement of the coupling face of the knuckle, but the amount and direction of this movement are dependent upon the relative positions of the lock and pivotal point, as will be subsequently shown.

By inspection of the diagrams already referred to, it will be seen that in fig. 1 there is the condition for greatest probable wear at the pivotal pin, while in fig. 5 there exists the condition for greatest probable wear at the lock, and in fig. 7 the total of the probable wear at the pivotal pin and the lock is very nearly reduced to the minimum.

It is evident that the outward movement of the coupling face of the knuckle caused by wear at the lock is, in each case, inversely proportional to the distance of the lock from the pivotal pin of the knuckle; but this outward movement caused by the wear at the pivotal pin varies with the position and direction of the bearing face of the lock relative to the pivotal pin and line of draught, and is different in every case. The action may be shown by diagram.

Take, for example, the case as represented in fig. 1, and let fig. 2 represent an exaggerated wear at the pivotal pin. This wear is in the direction of the line $A\ O$. The first effect of a pulling force is to bring the knuckle into the position shown in fig. 2; that is, the knuckle is made to move outward in the direction of the line $A\ O$ a distance equal to the wear $O\ O'$ at the pivotal pin, so that the shank is drawn away from the bearing face of the lock the same distance. The second effect is to draw the coupling face still further outward until the shank of the knuckle is brought in contact with the lock; and the final position taken by the knuckle is that indicated by dotted lines in fig. 3, the normal or first position being shown by full lines.

In the instance as shown by fig. 4, wear at the pivotal pin is developed as in the previous case in the line $A\ O$, but the bearing face of the lock is parallel to the line of action of the force acting on the pivotal pin, consequently a pulling force simply causes the knuckle to move outward and backward in that direction; and the shank of the knuckle thus moves along and not away from the bearing face of the lock as it does in fig 1. It follows that for an equal wear at the pivotal pin there is less outward movement of the coupling face of the knuckle.

In fig. 7 the outward movement of the coupling face of the knuckle is still further reduced for equal wear, for as the direction of the wear at the pivotal pin corresponds with the direction of the line $A\ O$, the first effect of a pulling force is that represented by fig. 8, and the final position of the knuckle is shown by dotted lines in fig. 9, where the full lines represent the normal position. In this case the shank of the knuckle, instead of being drawn away from the bearing face of the knuckle, is forced up against it and held so that by this action the coupling face of the knuckle is thrown forward relative to its first or normal position.

* Wear may, of course, be greatly reduced by case hardening or by similar means, and also by eccentrically attaching the coupler to the car so that a pulling force will have the effect of causing the two couplers to approach each other in a lateral direction, or, as it were, hug together and thus force the knuckle of one away from the guard-arm of the other.

† Any other wear on the lock will be small in comparison with that which takes place at the bearing face, and will not be considered.

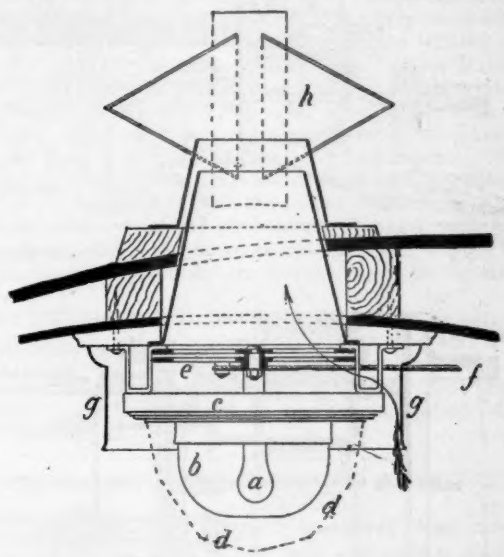
It is further obvious that in this latter construction a wear at the pivotal pin has the effect of causing a draft strain at the coupling face of the knuckle to draw this end of the knuckle toward the horn or guard side of the draw-head and in a direction away from the pivotal pin, so that it not only projects beyond the normal position but also becomes more inwardly inclined.

(TO BE CONTINUED.)

ELECTRIC LIGHTING OF CARS.

THE Jura-Simplon Railroad Company, in Switzerland, has for some time been trying the lighting of its passenger cars by electricity, with so much success that a number of additional cars are to be fitted with electric lights, and that light will be used in all new cars built for the line.

The plan adopted by this company, as described in the *Revue Internationale de l'Electricité*, is the storage battery system. The batteries used are made by the Société Suisse, at Marly, and are, it is believed, of the lightest type



ELECTRIC LIGHT FOR CARS.

yet devised. They are carried in a case placed under the floor of the car, each car being entirely independent so far as lighting is concerned; they can be removed and replaced entirely from the outside. The box or case for the batteries used in the ordinary six-wheel cars of the road is 15.4 × 29.2 in. in size and 19.3 in. deep, and the weight of the batteries is 245 lbs. These cars have three lights of 10 candle-power each and two of 8 candle-power each, besides a 5 candle-power light on each platform. This makes a total of 56 candle-power, and the batteries used will keep the lights burning for 13 hours without renewal. In the cars used in the through international traffic lights of 70 candle power are provided, and in these cars a heavier battery is used, which will last for 20 hours' continuous lighting.

The lights are placed in the roof of the car, generally directly under the ventilators; one of them is shown in the accompanying cut. In this *a* is the incandescent light; *b*, the glass globe surrounding it; *c*, the top and reflector; *d* the shade; *e*, the disc of the ventilator; *f*, the arrangement for opening or closing the ventilator; *g*, the frame; *h*, the ventilator chimney.

The wiring of the cars has been carefully done in order to secure the best possible insulation. Some trials have been made of an arrangement by which passengers can regulate the light, but the results have not been favorable.

So far as it has gone, the results have been favorable,

but the light provided is hardly sufficient; the substitution of lamps of 16 candle-power for those of 10 and 8 is recommended; but in that case the weight of the storage batteries must be considerably increased.

DETERIORATION OF CONDENSER TUBES.

A WASHINGTON correspondent of the New York *Times* reports a curious phenomenon which has developed on board the cruiser *Baltimore*. That writer says:

A thin ring on the inside had the color and appearance of the brass of which the tubes were originally composed, but outside of this the rest of the tube was of a dull copper color, without metallic luster, and giving the impression of fine particles of some material deposited from a solution.

The whole phenomenon was so entirely different from the usual experience with condenser tubes, which have generally been considered indestructible when intelligently treated, that an explanation seemed impossible. One theory was that the deterioration was caused by having the steam inside of the tubes instead of outside, as has always been the custom in the United States Navy; but

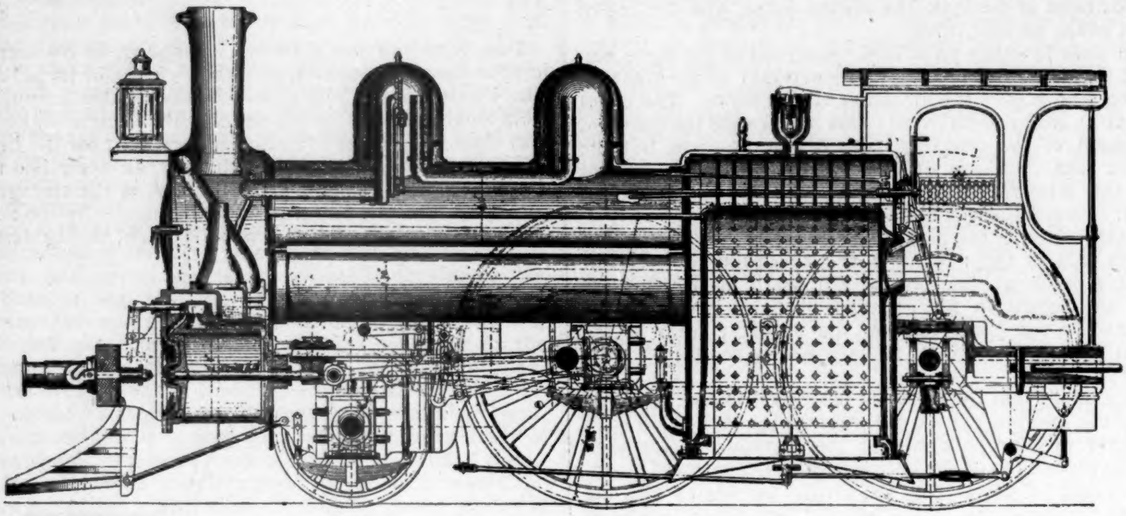


FIG. 1.—SECTIONAL ELEVATION OF ENGINE.

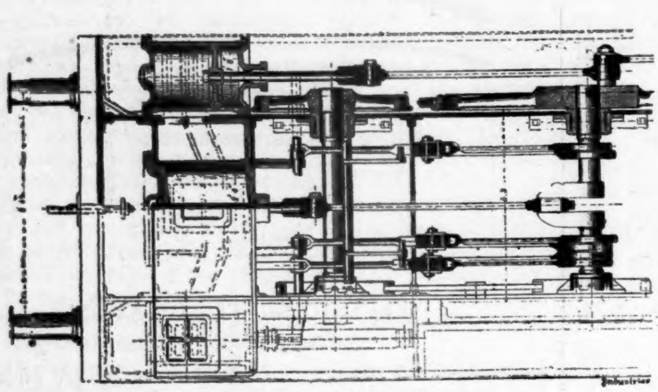


FIG 2.—PART SECTIONAL PLAN

DESIGN FOR A TRIPLE-EXPANSION LOCOMOTIVE.

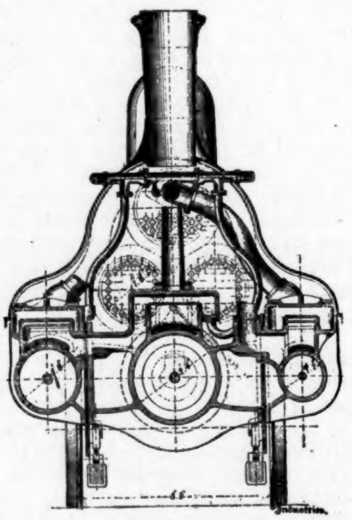


FIG. 3.—TRANSVERSE SECTION.

The deterioration of the condenser tubes of the cruiser *Baltimore*, with the necessity of replacing the entire lot, has called the attention of the Bureau of Steam Engineering in the Navy Department to a phenomenon which is certainly curious, and for which there has not thus far been an explanation advanced which has received general acceptance, or which is even entirely plausible.

The *Baltimore's* condenser is of English design, and carries out the English naval practice of having the steam inside of the tubes and the refrigerating water outside. Owing to a variety of causes, the space around one of these tubes became almost solid with mud, and when the vessel arrived at Mare Island recently, advantage was taken of the opportunity to remove the tubes and thoroughly clean out the condenser.

On removing the tubes there was nothing in their appearance to indicate that there was anything wrong with them, but it was found that a very light blow would break them across. This led to a careful examination, and it was found that all the tubes were in this condition. They could be broken across the knee as easily as a small stick. The fracture showed a complete change in the material.

no such occurrence has been reported with English condensers built in this way; and inquiry brought out the fact that a condenser of this pattern, in an American merchant vessel, had tubes which, after fourteen years of service, were as good as when put in.

Another theory was that, as no such trouble had ever been encountered while the shells of the condensers were of cast iron, the deterioration was consequent upon the use of brass condenser shells, the idea being that the tubes and the shell were sufficiently far apart on the electrical scale to form a battery in which the tubes were the positive pole and were attached, the zinc in them being dissolved out. This theory would seem quite plausible were it not for the fact that on the *Baltimore* and some other ships copper pipes connected with the condenser have also shown marked deterioration.

As far as can be learned, there has been trouble on nearly all the new ships with the copper pipes; and this is not confined to the American Navy, but the English have

had the same trouble. A correct explanation will be of great interest to all mechanical engineers. A chemical analysis of some of the defective tubes of the *Baltimore* is now in progress, and when it is completed, it may throw some light on the subject.

A TRIPLE-EXPANSION LOCOMOTIVE.

THE accompanying illustrations, from *Industries*, show a triple-expansion locomotive which has been designed for the Northwestern Railroad of Beloochistan by the Engineer of the road, Mr. John Riekie. The road is of 5-ft. 6-in. gauge, and is, we believe, an extension of the Northwestern of India.

The boiler, it will be seen, is of peculiar construction. The fire-box is of the ordinary shape, but the barrel consists of three separate cylinders connected to the outer fire-box casing at the rear end, and to the smoke-box at the front. The upper one of the three is 24 in. in diameter and is about half full of tubes; the two lower ones are 21 in. in diameter and are filled with tubes. There are 130 tubes altogether, 1⅝ in. in diameter, 52 in each of the lower cylinders and 26 in the upper one. The fire-box is 62 × 49½ in. inside.

The engine is carried on four coupled wheels 7 ft. 11½ in. in diameter and one pair of leading wheels 4 ft. 3 in. in diameter. The total wheel-base is 16 ft. 2 in.

There are three cylinders arranged as shown, the high-pressure outside on one side, the intermediate on the other, and the low-pressure in the center; the latter is connected to a crank in the main driving-axle. The steam pipes connecting the cylinders are apparently intended to act as receivers. A special pipe and valve are provided, by which steam can be admitted at boiler pressure to both the high pressure and intermediate cylinders at once, for use in starting a train. The valve motion is of the hanging link type, and each cylinder has its own separate eccentrics, links, etc., as shown.

The cylinders are 14 in., 20 in., and 28 in. in diameter and 26-in. stroke, the ratio of the high-pressure cylinder to the others being 1 : 2.04 : 4.00.

It is not stated whether this locomotive is under construction, or whether it is still simply a design. The boiler pressure at which it is to work is not given.

RUSSIAN RAILROADS IN ASIA.

THE Technical Commission, to which was entrusted the duty of deciding on the final location of the Trans-Siberian Railroad, has decided in favor of the line which was described by our Russian correspondent in the articles published in the JOURNAL some time ago.* This line starts from Zlatooust, the present terminus of the Samara-Oufa line, and will pass through Omsk, Nijni-Udinsk, Irkoutsk, Krasnoiarsk, and around the southern end of Lake Baikal to the upper waters of the Amour, and will then follow that river and its chief southern affluent, the Oussouri, to Grafskaia, whence it will run nearly due south to Vladivostok. The total length is about 4,900 miles, but nearly one-third of this is covered by river navigation, which can be used to supplement the sections of the railroad as they are built.

The western section, from Zlatooust to Omsk, traverses the best cultivated and most thickly inhabited parts of Siberia, and with a branch to Tomsk, and connections with river navigation on the Obi and the Irtish, may be expected to develop a considerable business. The central section, from Omsk to Irkoutsk, is through a rough and thinly peopled region, and but little traffic can be expected from it unless the building of the road leads to the development of its mineral resources.

A branch which will doubtless be built from some point near the southern end of Lake Baikal to Kiakhta will bring to the road the very considerable trade with China, which is all done through Kiakhta, and is now carried in the winter by caravans of freight sledges.

On the western end the Samara-Oufa line, which is the connecting link with the railroad system of European Russia, is now being extended from Zlatooust, its present terminus, a distance of 115 miles to Miask, which is the center of the gold mines of the Eastern Oural. The beginning of work on the road from Vladivostok on the Pacific to Grafskaia on the Oussouri has already been noted.

It may be added that the engineers are now making a careful study of the more important river crossings. At several of those car ferries will be established, to be replaced by bridges after the railroad is completed. Some of the bridges on the Siberian Railroad will rank among the great engineering works of the world; notably the crossings of the Tom, the Tobol, the Obi and the Irtish; and the whole line is the most important railroad work now in progress anywhere in the world.

THE Russian Trans-Caspian Railroad, which was originally a purely military line, is developing gradually a commercial business of considerable amount. The caravan traffic which passed through Bokhara and Merv has gone to the railroad, and already some local business has sprung up from the Russian settlements. General Annenkoff, who built the road, and who is an engineer of no ordinary ability, saw that the settlement of the country depended entirely upon irrigation, and the works planned by him are now being carried out. The Galodnaia Steppe is already receiving water from the Sir-Daria, and work has been begun on a canal which will carry the waters of the Oxus to Bokhara and restore the ancient fertility of the country around the old Tartar city. Some irrigation works on the imperial domain of Bairam-Ali are nearly completed. The country around Pendjeh is also to be irrigated, and water will be brought from the Zarafshan and the Tchirtchick to Tashkent and Samarcand. Works of the same kind for the oasis about Askhabad are designed, but not yet begun. In fact, the improvements there and at Sarakhi, which General Annenkoff planned, will not be carried out until the sources of the water supply in the mountains of Khorassan are brought fully under Russian control.

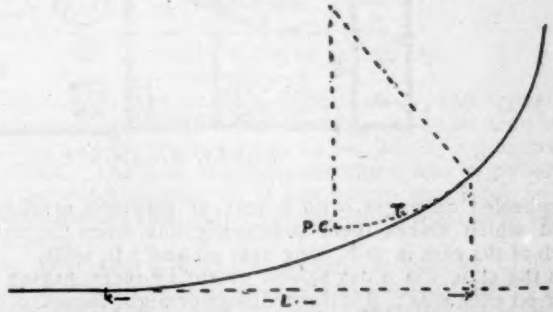
The Merv oasis, it is now believed, cannot be reclaimed to any extent, owing to want of water; and the town of Merv will have to depend, not upon the surrounding country, but upon its importance as a trading post and as a strategic point in the event of operations against Afghanistan and India.

A SHORT RULE FOR TRANSITION CURVES.

THE following short rule for laying out these curves is submitted by Mr. J. F. Ward, who claims that it is practical, easy and sufficiently correct for general use:

TRANSITION CURVES.

Offset $P\ C$ as desired to any extent, and run in the points of circular curve as usual, with chords of length suited to



the curvature; then measure from $P\ C$ along the curve to any point where you wish to connect the transition curve, and call the distance T.

Measure the ordinate from this point to the tangent, and call the length O.

Find D = the degree of curvature of the circular curve, then $\frac{O \times 17.000}{D\ T} = L$, the length of the transition curve measured on the tangent.

Having L and O given, calculate the intermediate ordinates as proportional to the cubes of their abscissæ.

* See the RAILROAD AND ENGINEERING JOURNAL for June, September, November and December, 1890, January, February, March and July, 1891.

ENGLISH SALOON CARS.

In a recent paper published in *Glaser's Annalen*, Herr Büte describes a number of the special saloon or drawing-room cars on English railroads. Those given herewith,

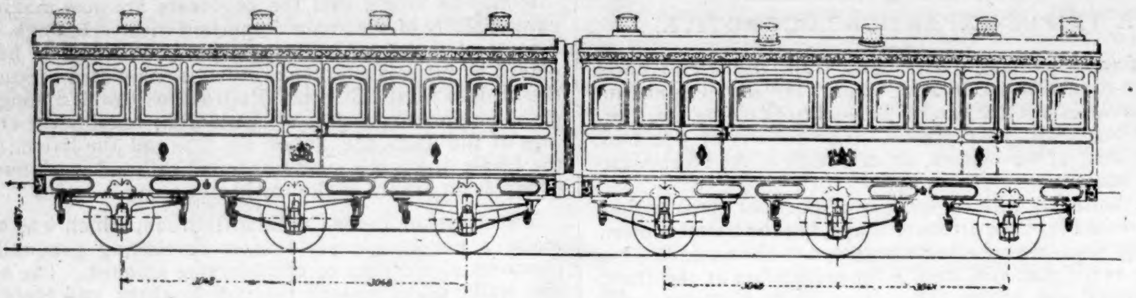


Fig. 1.

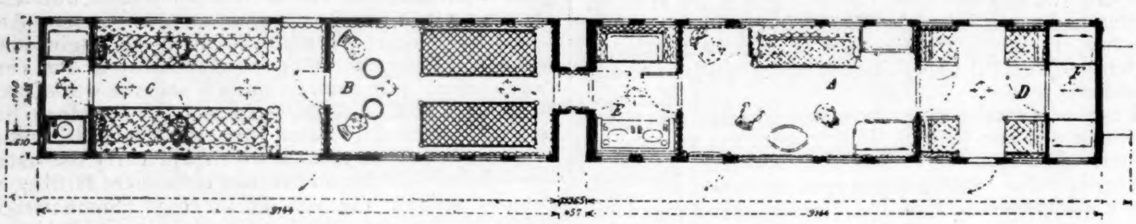


Fig. 2.

ROYAL SALOON CAR, LONDON & NORTHWESTERN RAILWAY.

like nearly all the others, are special cars intended for the use of distinguished persons.

Figs. 1 and 2 show an elevation and plan of the cars constructed for the use of the Queen, on the London & Northwestern Railroad. These are, it will be seen, two

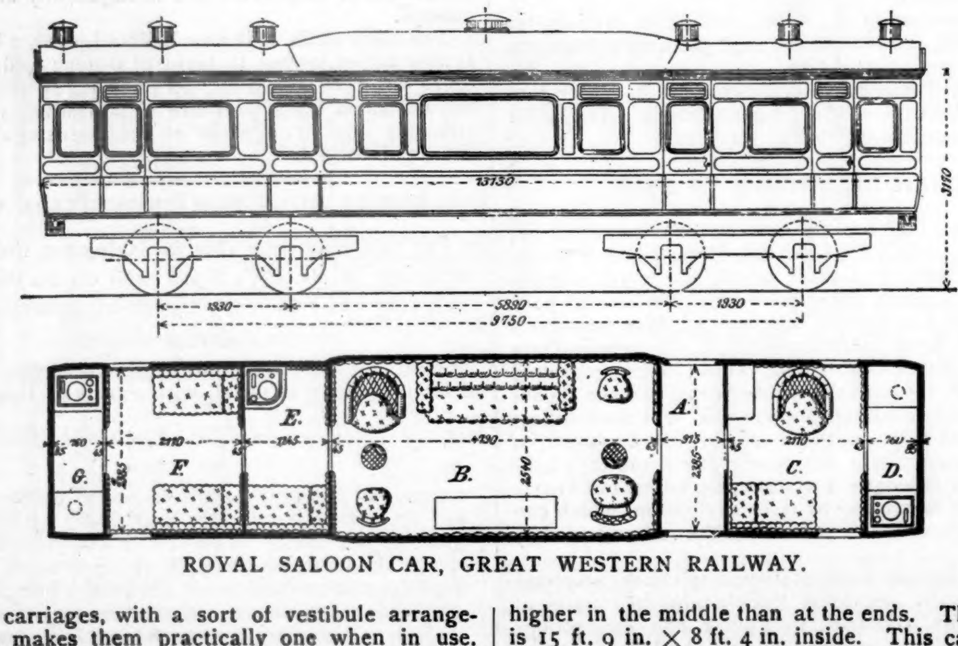


Fig. 3.

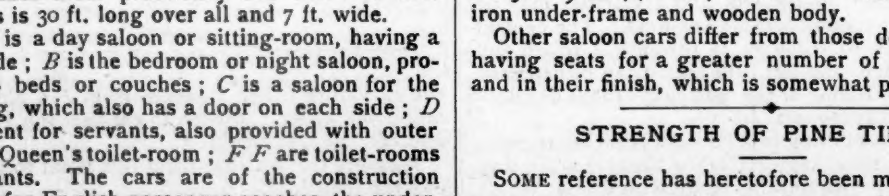


Fig. 4.

ROYAL SALOON CAR, GREAT WESTERN RAILWAY.

six-wheeled carriages, with a sort of vestibule arrangement which makes them practically one when in use. Each of the cars is 30 ft. long over all and 7 ft. wide.

In the plan *A* is a day saloon or sitting-room, having a door on each side ; *B* is the bedroom or night saloon, provided with two beds or couches ; *C* is a saloon for the ladies-in waiting, which also has a door on each side ; *D* is a compartment for servants, also provided with outer doors ; *E* is the Queen's toilet-room ; *F F* are toilet-rooms for the attendants. The cars are of the construction usually adopted for English passenger coaches, the under-frame being of iron ; the car-body is of oak, pine and teak, and the finish is in mahogany.

Figs. 3 and 4 show a car lately built for the Queen at the Great Western Railroad shops at Swindon. This car is 43 ft. long and 8 ft. 10 in. wide ; it is carried on two four-wheeled trucks. Unlike the first one shown, it has no sleeping-room, being intended for short journeys only.

In the plan, fig. 4, *A* is the entrance passage, with a door at each end ; *B* is the main saloon, provided with a sofa, chairs and a table ; *C* is a room for attendants, having a door at each side and a toilet-room, *D*, opening into it ; *E* is a private toilet-room opening from the main saloon ; *F* is another room for attendants, also provided with outside doors and a toilet-room, *G*.

It will be noticed that this car is a little wider and higher in the middle than at the ends. The main saloon is 15 ft. 9 in. × 8 ft. 4 in. inside. This car also has an iron under-frame and wooden body.

Other saloon cars differ from those described chiefly in having seats for a greater number of persons provided, and in their finish, which is somewhat plainer.

STRENGTH OF PINE TIMBER.

Some reference has heretofore been made to the important timber tests which the Forestry Division of the Department of Agriculture is now conducting. The circular given below shows the results of one of these tests :

Among the investigations of timber which for the last six months have been carried on by the Forestry Division,

as described in Circular No. 7, one series of tests was instituted to determine the effect which the practice of gathering resinous matter for the manufacture of turpentine and naval stores from the longleaf pine of the South may have upon the strength of the timber of trees subjected to this practice.

The gathering of resin is done by cutting a recess (box) into the foot of the tree, which is called "boxing" the tree, and then scarring (chipping) the trunk above the box, increasing the size of the scar from year to year. From this scar the semi-liquid resin exudates and drains into the box ; this process is continued for four years, and then the trees, lessening in yield, are abandoned.

The current public belief has been that the timber of these "boxed" trees, sometimes called "turpentine timber," is deteriorated by the process. Not only is its durability, in which this species excels, believed to be lessened, but also its strength, and hence its value in the market has been considerably reduced.

Since annually from 500,000 to 750,000 acres of this pine are boxed, involving in this assumed deterioration, at the lowest estimate, 1,000,000,000 ft., B. M., of lumber, a considerable loss in values, counting by millions of dollars, is thereby incurred.

As far as durability is concerned, there seems little doubt that the withdrawal of the resinous matter, which furnishes protection against the penetration of water and seems also to have antiseptic properties, reduces the capacity to withstand rot at least in some parts of the tree ; the portion near the scar, where the resin accumulates, of course becomes more durable. But it did not seem reasonable that the strength in general should suffer. The tests conducted in the test laboratory at St. Louis, in charge of Professor J. B. Johnson, give countenance to the important conclusion, that "*turpentine" timber seems to possess greater strength than timber from unboxed trees.*

Although the tests and examinations of this series are not yet completed, and further study will perhaps necessitate modifications of this general statement, the economic importance of the discovery seemed to call for immediate preliminary publication, especially since the investigation had to be interrupted for lack of funds and may, therefore, not be continued for some time, delaying verification and fuller conclusions.

The mean of 115 tests of boxed timber, and of 133 tests of unboxed timber shows the following results :

	Boxed Timber.	Unboxed Timber.
Tensile strength............	15,485 lbs. per sq. in.	16,429 lbs. per sq. in.
Compressive strength endwise	6,935 lbs. per sq. in.	5,661 lbs. per sq. in.
Cross-breaking strength.....	11,118 lbs. per sq. in.	9,333 lbs. per sq. in.
Modulus of elasticity.......	1,694,000 lbs. per sq. in.	1,800,000 lbs. per sq. in.
Elastic resilience..........	2.76 lbs. per cu. in.	1.92 lbs. per cu.in.
C'mpr'ssive str'gth acr'ss g'n	1,122 lbs. per sq. in.	855 lbs. per sq. in.
Shearing strength....... ...	636 lbs. per sq. in.	652 lbs. per sq. in.

A detailed account of the experiment will be published later, when tests and examinations are fully completed. It is here intended only to give the basis upon which the above conclusion is stated.

The test material was collected at Wilson's Station, Alabama, consisting of eight trees which had been boxed and abandoned five years, and 11 trees which had been worked for the last time during the past season. These trees furnished, besides some 50 disks for physical examination, 20 logs for tests. From these 115 test pieces for each kind of test were prepared. For comparison 40 logs from 11 unboxed trees, collected at Wallace and Thomasville, Alabama, furnished 133 test pieces for each kind of test.

It having been established as a law that strength changes with the amount of seasoning, it became necessary to establish the ratio of change due to seasoning in the boxed timber (which had been tested green), by special tests on 25 sticks taken from corresponding positions in the tree which were seasoned. Then the tests on all the green sticks were corrected for 20 per cent. moisture, corresponding to the moisture percentage of the unboxed timber. The results are exhibited in condensed form in the accompanying table.

Since among the unboxed specimens there were quite a number from higher positions in the tree than those of the boxed specimens, which were mainly taken at a height of 7 to 33 ft. above ground, a selection was made of the results of 15 tests made on sticks of nearly like position and diameter of tree, both boxed and unboxed. In this comparison the numerical value of the difference is naturally reduced, but not the general tendency, namely, to show that "turpentine" timber, while exhibiting less tensile and shearing strength, is tougher than that from unboxed trees, and has greater compressive and cross-breaking strength. At the same time it may be stated that turpentine timber proved itself harder to work, the resin collecting in spots gumming up the tools.

The possibility of flaws in experiments of this kind makes it proper to caution against full acceptance of the results until further verified. Especially is it desirable to extend the investigations into the higher portions of the tree, for while no deterioration seems to take place near the scar of the tree, perhaps because the resinous juices are drained in that direction, it is possible that the wood of the higher portions of the tree may be changed, either for worse or for better. There has not been time yet to study the physical changes which have taken place in the different parts of the tree due to the boxing.

We feel, however, justified to maintain that the claimed inferiority of turpentine timber in strength does not exist.

Information regarding authenticated cases of practical observation on this point is solicited by the Division.

PROGRESS IN FLYING MACHINES.

BY O. CHANUTE, C.E.

(*Continued from page 135.*)

REALIZING the utter insufficiency of man power, or of any known primary motor, some inventors have designed flying screws to be worked by new-fangled motors. Of these was the apparatus of *Pomès & de la Pauze*, proposed in 1871, and shown in fig. 30. The sustaining screw

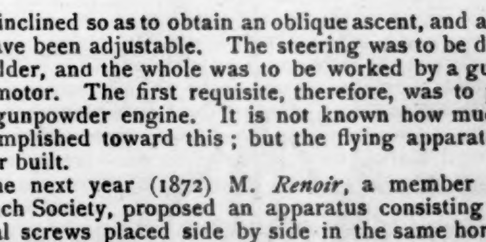


FIG. 30.—POMÈS & DE LA PAUZE—1871.

was inclined so as to obtain an oblique ascent, and appears to have been adjustable. The steering was to be done by a rudder, and the whole was to be worked by a gunpowder motor. The first requisite, therefore, was to perfect the gunpowder engine. It is not known how much was accomplished toward this ; but the flying apparatus was never built.

The next year (1872) M. *Renoir*, a member of the French Society, proposed an apparatus consisting of two aerial screws placed side by side in the same horizontal plane, but with shafts capable of being moved out of the vertical, in order to secure movement in both directions. They were to be driven by steam, and to rotate in opposite directions ; and M. *Renoir* computed that the axis of rotation would have to be inclined 11° in order to obtain a horizontal course. Also, that to produce satisfactory forward speed, the additional power required would be but 10 per cent. of that required for sustaining the weight. Aside from the main question of the motor, which was left in abeyance, the important thing to ascertain was the best form of sustaining screw, in order to get the

utmost support with the least expenditure of power; so the succeeding year, M. *Renoir*, having studied the results obtained by M. *Pillet* with a concave screw * in a series of experiments beginning in 1848, tried some experiments of his own with a screw provided with a return flange or turned edge, to prevent the centrifugal escape of the air, of which he gave an account in the *Aëronaute* for April, 1873.

He drove his screw by man power, and claimed that the results showed that a force of one horse power could sustain, by means of his screw, a weight of 165 lbs.; but Mr. *Bennet*, in giving an account of these experiments to the Aeronautical Society of Great Britain, in 1874, gave a somewhat different account, and said:

Two years ago M. *Renoir*, a member of the French Society, experimented with a screw 15 ft. in diameter, with which, by the action of his feet, he was able to lift a weight of 26 lbs. The screw was two bladed, with an increasing pitch, the angle of inclination being 3° at the front edge of the blade and increasing to 30° at the back edge. The two blades cover the entire area of the screw, and have a deep rim suspended from them to prevent the air being driven from the circumference by centrifugal force. M. *Renoir* estimated the power he developed was about one fifth of a horse power; but this was considered by the members of the French Society present at the experiment to be considerably below the real power exerted. As the screw was driven by the feet, after the manner of a velocipede, the body being in a good position for exerting its maximum effort, the power developed was undoubtedly nearly one horse power. A man running up a pair of stairs is able for a few seconds to exert two horse power, and mounting a ladder placed vertically, by the help of his hands, an ordinary man can do the work of 1¼ horse power. These facts have been determined by experiment.

While on the subject of the form of screws, it may be well to call the attention of those who may desire to study the subject further to an article upon "Propulsors," by M. *Crocé Spinelli* (the same gentleman who lost his life in the scientific balloon ascension of the *Zenith*), which will be found in the *Aëronaute* for April, 1870, and to another by the same author on "A Screw with Variable Pitch" in the *Aëronaute* for November, 1871. Also to the remarks on screws by Mr. *Wenham* in the first and second reports of the Aeronautical Society of Great Britain, and to those of Mr. *Thomas Moy*, in the fourth report of the same society. He evidently knew what he was talking about.

In 1872 Mr. *Wenham* proposed a method for varying the pitch of the screw, which may be found in the report of the British Aeronautical Society of that year. The blades were to be made of some fabric, one edge being attached to a cross arm, which was made fast to the shaft of the screw. The other edge of the fabric was fastened to another cross arm, so arranged as to be placed in any position on the shaft, and firmly fixed in such position. A coiled spring was to keep the two cross arms apart, and thus maintain the fabric tightly stretched. If the adjustable arm be placed precisely in line with the fixed arm, then the blade is parallel with the shaft, and by moving

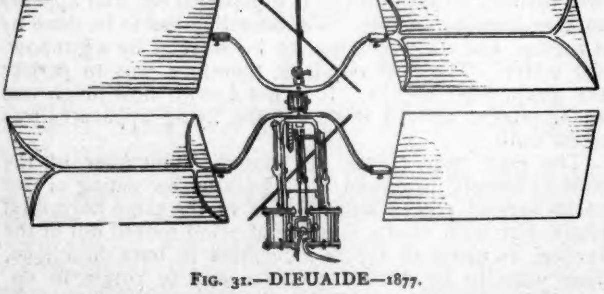


FIG. 31.—DIEUAIDE—1877.

the adjustable arm to one side more or less, the pitch can be made anything desired.

The next experiments on screws were tried in 1877, by M. *Dieuaide*, formerly Secretary of the French Aeronautical Society, and the well-known Engineer and Patent Attorney, whose clever *chart* has furnished (by permission) almost all the illustrations contained in these articles. His apparatus is shown in fig. 31. It consisted of two pairs of square vanes set at various angles to the line of motion, so as to vary the pitch, and rotated in contrary directions by gearing. The power was furnished by a double cylinder steam-engine connected with the boiler by a flexible hose, and the lifting power of the screws could be accurately weighed by simply putting the apparatus on a scale.

The results of the experiments seemed to show "that this double screw could not, in consequence of the losses of power due to the gearing, exert a lifting force greater than that of 26.4 lbs. per horse power." This agrees closely with the results of the experiments of *Giffard* with a single screw; he having found that 6 horse power would lift with a screw 165 lbs. at the rate of 3.28 ft. per second, or say 27.5 lbs. per horse power, from which he deduced the conclusion that the aerial screw gave out but 18 per cent. of the power exerted to drive it.

The next apparatus to be noticed was not experimented with, so far as the writer has ascertained, but was a proposal of great oddity and originality patented in 1877 by M. *Mélikoff*, Engineer and graduate of the school of the "Ponts-et-Chaussées." It is shown in fig. 32, and consisted in a sort of screw parachute composed of "two hyperbolic paraboloids united by their concavities into a

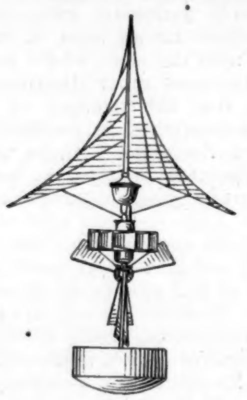


FIG. 32.—MÉLIKOFF—1877.

sort of cone or pyramid with a rectangular base in projection." This was to be furnished with a series of zones, shown in section in the figure, to act upon the air; and this arrangement, the one resembling a spear-head in the figure, was expected to screw itself up into the air and to act as a parachute in coming down. It was to be rotated by a gas turbine, consisting of eight curved chambers, into each of which charges of the vapor of ether mixed with air were to be successively exploded by an electric spark, and the charges allowed to expand in doing work. The surfaces were to be kept cool by melting ice and by heating the resulting water. This ice and the supply of ether were to be carried in the recipient shown just below the parachute, the turbine being shown lower down; this motor was expected to work also an ordinary screw with three arms, geared on a short axle, from which screw horizontal propulsion was expected. Below all is shown the car for the operator.

M. *Mélikoff* designed his apparatus to carry up one man, and estimated its total weight at 374 lbs. Of this the apparatus proper was to absorb 108 lbs., the gas turbine was to weigh 92 lbs., its supplies for one hour were to amount to 40 lbs., and the operator was to be of 134 lbs. weight. The rotating surface was to measure 87 sq. ft. in area, thus giving a proportion of 4.3 lbs. to the sq. ft., which seems entirely too small, although claimed to be calculated from the tables of air pressures given by *Thibault*. The turbine was to be of 4 horse power, being thus estimated to weigh 23 lbs. per horse power, and it was to consume per horse power per hour 3.3 lbs. of ether and 8.7 lbs. of ice for cooling the parts, thus showing a slight discrepancy from the aggregate of 40 lbs. of supplies estimated as required for one hour.

The apparatus as a whole is scarcely worth experiment-

* *Aëronaute*, March, 1870.

ing with, and has been chiefly described because of its oddity; but the weight and power of the projected gas turbine seem to have been worked out with some care, and it might be worth while to take the subject up again, in order to ascertain whether it is practicable to construct a rotary gas motor weighing as little as 23 lbs. to the horse power.

The next experiment to be noticed was tried by M. *Castel*, a mechanical engineer, in 1878. He wanted to determine the amount of mechanical work required to sustain a motor in the air, and built the apparatus shown in fig. 33. It consisted of eight double screws rotated in opposite directions by a double-cylinder compressed-air engine,

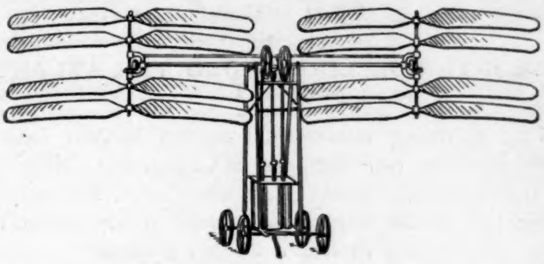


FIG. 33.—CASTEL—1878.

mounted upon wheels and fed with compressed air through a long, very light rubber hose. The weight of the whole apparatus was 49 lbs., of which 22 lbs. was in the screws and their machinery. The screws were 3 93 ft. in diameter, and weighed 1.32 lbs. each.

Experiments were repeatedly tried, but they came to an early ending by the apparatus rising upon the air, taking a sheer, and smashing itself against the wall of the room. M. *Castel* did not publish the results accomplished in the way of lifting a measured number of pounds per horse power developed; but he stated that he "no longer had the confidence which he once possessed in screws as future instruments of aviation. Elastic surfaces with an alternating action to impart vibratory motion to the air now seem preferable to screws to solve the problem of aerial navigation with an apparatus heavier than the air." He estimated from an examination of the muscles of birds and of the amount of work which those muscles were able to give out, that the bird in full flight expended not more than 24 foot-pounds per minute for each pound of his weight, so that a bird, if he weighed 220 lbs., would only expend a maximum of 0.16 horse power.

Now, we have already seen that the average power of a man is 0.13 horse power, and that although he weighs less than 220 lbs., he cannot fly with wings by his muscular efforts, so that the estimate must be erroneous.

M. *Castel* proposed to build a petroleum motor to drive his proposed wing apparatus, but he probably found himself unable to keep within the necessary limits of weight.

A simpler apparatus than M. *Castel's* accomplished much better results, for in the same year (1878) Professor *Forlanini*, an Italian civil engineer, launched into the air the second steam apparatus which has flown with its contained supply of steam; the first having been that of Mr. *Phillips*, already described. Fig. 34 shows the flying screw arrangement experimented with by M. *Forlanini*.

It is composed of two double-bladed screws, of which the lower one is rigidly fixed to the steam-engine, while the upper one rotates; the result being that the lower screw furnishes a fulcrum upon the air, while the upper one furnishes the ascending power. The whole apparatus thus slowly rotates upon its own axis; but this feature, which would be very objectionable in a really navigable apparatus, could be eliminated by rotating both screws in inverse directions.

The upper screw was worked by a double cylinder steam engine of ¼ horse power, supplied with steam from superheated water contained in a depending hollow globe after the manner of the well-known fireless locomotive, the initial pressure being some 120 to 160 lbs. per sq. in. It was the original design of M. *Forlanini* to send up his apparatus with a steam boiler attached, fired by 200 minute alcohol flames; but this proved too heavy to be lifted by the machine, and he substituted the hollow globe, tested to an internal pressure of 225 lbs. per sq. in., which, being two-thirds filled with water, is simply laid upon a fire until the desired pressure is obtained; when, on being withdrawn, the throttle-valve which admits steam to the cylinders is opened, and the apparatus rises.

It has been repeatedly tested, and its best performance seems to have been to rise to a height of 42 ft. and to remain 20 seconds in the air. M. *Forlanini* expressed the intention of following it up with an improved apparatus, of which he had the design, and with an engine of 2 horse power; but it is stated that he has not had the leisure to carry out this intention.

The total weight of the original apparatus was 7.7 lbs., and the aggregate area of the screws was 21.5 sq. ft., thus giving a bearing surface of about 2.8 sq. ft. per pound. The weight of the steam-engine proper was 3.52 lbs. and that of the screws 1.32 lbs. The hollow globe, charged with water, weighed 2.20 lbs., and the steam-gauge and connections weighed 0.44 lbs. more, leaving 0.22 lbs. for other accessories. It will be noticed that the engine, the boiler and the gauge weigh about 80 per cent. of the whole, which proportions could not be expected to obtain in a navigable apparatus; but, on the other hand, a larger steam-engine and boiler would weigh less in proportion to its power than the minute one thus experimented with, in which steam was very wastefully used in consequence of the relatively very large proportion of radiating surfaces.

M. *Forlanini* designed a self-generating steam boiler, which he expected to weigh but 13.2 lbs. per horse power; but it is not known to have been constructed.

This, then, is the best that has hitherto been done with steam. A model screw machine weighing 7.7 lbs. has risen 42 ft. into the air and flown for 20 seconds, but without taking up a self-generating steam boiler. The power

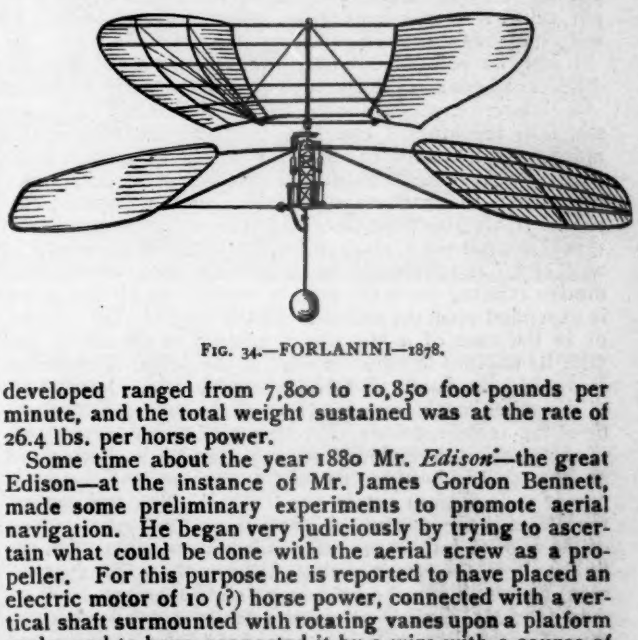


FIG. 34.—FORLANINI—1878.

developed ranged from 7,800 to 10,850 foot pounds per minute, and the total weight sustained was at the rate of 26.4 lbs. per horse power.

Some time about the year 1880 Mr. *Edison*—the great Edison—at the instance of Mr. James Gordon Bennett, made some preliminary experiments to promote aerial navigation. He began very judiciously by trying to ascertain what could be done with the aerial screw as a propeller. For this purpose he is reported to have placed an electric motor of 10 (?) horse power, connected with a vertical shaft surmounted with rotating vanes upon a platform scale, and to have connected it by a wire with a source of electric power—the object being to ascertain how much the whole could be lightened by the action of the vanes upon the air.

He rigged upon the shaft first one kind of propeller, and then another, until he had tried all that he could think of; the best being a two-winged fan with long arms.

He is reported as saying that the best results obtained were to lighten the apparatus some four or five pounds of its total weight of 160 lbs., but the amount of power developed is not stated. This must have been quite small, and Mr. *Edison* must have been unfortunate in his selection of the screws to be tried, for we have seen, by the experiments of others, that a motor of 10 (if it was really this) horse power ought to lift 260 lbs. It is no wonder that he is reported as saying that "the thing never will

be practicable until an engine of 50 horse power can be devised to weigh about 40 lbs."

It is understood that somewhat similar experiments were tried by Mr. *Dudgeon*, the celebrated maker of hydraulic jacks. He tested the lifting effect of various forms of screws when rotated by steam power, and, like Mr. *Edison*, he stopped in disgust when he found how small was the lift in proportion to the power expended.

There may have been other experiments with lifting aerial screws in the United States, but they have not come to the knowledge of the writer. In point of fact, such aerial devices do not seem to have received much attention from inventors, and there have been but few patented proposals therefore in the United States.

In 1876 a patent was taken by Mr. *Ward*, of San Francisco, for an aerial vessel in which the supporting and the propelling power was to be furnished by a series of fan blowers. The fans furnishing the support were placed on horizontal shafts and the exhaust opened downward, so that the reaction would act against the force of gravity, while the fans which produced the horizontal motion were also arranged on horizontal shafts at the rear, the air being conducted to them through a duct from the front, and exhaust being to the rear, so that the reaction would force the vessel forward.

In 1877 Mr. *Ward* took out further patents, in which the apparatus was somewhat modified, but the general principles remained the same. It is believed that he tried some experiments; but no record of them has been met with by the writer, and a letter to the inventor has remained unanswered.

The same idea, but in a modified form, has quite lately (1892) been patented by Mr. *Walker*, of Texas; and perhaps experiments will be tried to test the lifting effect of air blasts under favorable circumstances; but as the efficiency of a screw, when used as a fan, is stated at only 35 per cent., while its efficiency as a propeller is stated at 70 per cent., it seems a question whether air blasts can be advantageously used in aerial navigation.

It may be pointed out here that there is a considerable difference between the fan blower and the screw propeller—a difference which should be more thoroughly understood by inventors. The most efficient fan blower is a machine which will produce the strongest current of air with any given expenditure of power. The best screw propeller is the machine which will produce the least current. If a screw propeller could be so arranged that it would not put the air in motion at all, then there would be no "slip," and the machine would be as efficient as a locomotive running on a dry rail, in which case all the power is expended upon the vehicle. In the case of a fan blower, or in the case of a steamboat moored to the wharf, and with its engines in operation, all of the power is expended in moving the fluid. It is all wasted in slip. In the case of the steamboat advancing through the surrounding fluid, or of the aerial machine, if it ever gets under way, a part of the power is expended in putting the craft in motion and another part in putting the fluid in motion, and the latter power is inefficient; it is the "slip." The best screw, therefore, is the one which shall expend the greatest part of the applied force upon the craft and the least upon the fluid. It is the screw which will create as little movement as possible in the fluid in which it operates.

In 1879 Mr. *Quinby* patented a device consisting of two sets of screw-like sails, one set to raise the machine and the other to propel it. The drawing shows a light framework with two screws, each with two blades of fabric, one set on a vertical mast, and the other upon an inclined mast. The screws were to be driven through rope gearing by some source of power.

In the same year Mr. *Greenough* also patented an apparatus, which should better, perhaps, be noticed under the head of aeroplanes, but which differed from this type by having lifting screws imbedded in the surface of the aeroplane, in order to obtain a lifting action upon first getting under way, after which, by sailing at an angle, both sustaining and propelling effect could be obtained from the screws, with, however, the possible addition of a vertical screw to give increased forward motion. This inventor is understood to have tried some preliminary experiments of details, and as a result thereof to be awaiting the development of a light motor before undertaking to realize his conception upon a navigable scale.

In 1885 Mr. *Foster* patented an air ship consisting of two screws, four-bladed, side by side, on separate vertical shafts, which latter can be thrown at an angle by reason of a flexible portion connecting with the main driving shaft, so that the thrust may both lift and propel the apparatus. The main shaft was to be driven by the feet of an operator sitting below and half way between the two screws. These screws are apparently some 8 ft. in diameter, and the man power relied upon is evidently inadequate, so that it is quite safe to say that if the apparatus was ever tried it did not succeed in rising.

(TO BE CONTINUED.)

THE INTERIOR LINE ALONG THE ATLANTIC COAST.

THE following statement, compiled by Mr. John C. Trautwine, Jr., from the notes of Captain S. C. McCorkle, for the *Proceedings* of the Engineers' Club of Philadelphia, shows how far the way for the interior or land-locked line from New York to Florida is already prepared.

Briefly outlined, the route from New York City to Charleston would pass through Raritan Bay and up the Raritan River to New Brunswick, N. J.; through the Delaware & Raritan Canal to Bordentown, N. J.; down the Delaware River to Delaware City; through the Delaware & Chesapeake Canal to Chesapeake Bay; down this bay to Norfolk, Va.; from Portsmouth (opposite Norfolk) up Southern River and through the Albemarle & Chesapeake Canal, North Landing River, Currituck Sound, a short canal and the North River, into Albemarle & Pamlico Sounds; and thence through Core Sound to Beaufort and Moorhead City, N. C.; thence by sheltered inlets, on which some work would be required, to Cape Fear River, N. C.; and from this point, by a series of streams and bays and sheltered inlets, aided by canals, existing and contemplated, to Charleston, S. C.

From New York to Beaufort and Moorhead City, N. C., the route is already open to vessels drawing 7 ft., except that some little dredging would be required at Piney Point, in Core Sound, between Pamlico Sound and Beaufort.

The "Bight" inside Cape Lookout shoal, near Beaufort, is said, by Captain D. A. French, of the Lighthouse tender *Laurel*, to be "a splendid harbor with any wind wind in 18 ft. of water."

From Moorhead City to near Bogue Inlet, 25 miles, the least depth shown on the charts is 2.5 ft., but there are much greater intervening depths. From Bogue Inlet to New River Inlet, 15 miles, there are channels through sea marsh, but their depth has not yet been ascertained. From New River Inlet through Old Topsail Inlet to the western end of Myrtle Sound, 50 miles, the route passes through a series of bays and sounds, giving a nearly continuous water passage; but only a few soundings have here been made.

From Myrtle Bay a canal about 2.5 miles long would have to be cut through low ground to the channel of the Cape Fear River.

The total distance from Moorhead City to the Cape Fear by this route would be about 92.5 miles. Being all inside, it would avoid the shifting sand-bars of the North Carolina coast, and the dangerous navigation around Cape Lookout and Cape Fear; and judging from the success of the Albemarle & Chesapeake Canal, there is every reason to believe that it would remain in permanent and active operation.

From the Cape Fear River at Southport (formerly Smithville), N. C., to Charleston, S. C., there is an outside route of about 125 miles, with 14 ft. mean low water over the bar at the port at each end. This was formerly the mail route; and the steamers, although very frail and of small power, were very successful.

The inside route, about 140 miles long, between the same two points, would pass up Elizabeth River to Hickory Point, whence a canal two miles long would have to be cut

through swampy land to water communication with Lockwood's Folly, Shallotte Inlet and Little River Inlet. Between Little River Inlet and Morrill's Inlet, a distance of 30 miles, is a low, flat, swampy district, which would have to be specially surveyed, and probably some canaling would be required.

From Morrill's Inlet to Georgetown, S. C., there is water communication. Between Georgetown and Cape Romain River two short canals may be necessary, one of which (the U. S. canal) has been partially, if not fully, constructed.

From Cape Romain River to Long Island, *via* Bull's Bay and following the creeks, there is water all the way, but some straightening and dredging will doubtless be required. From Long Island to Charleston there is water communication, but the depth is not known.

There always has been an inland passage between Charleston and Fernandina. Before the building of the Savannah & Charleston Railroad, the mail and passengers bound south were always carried by boat from Charleston to Savannah; and the steamboats, after touching at Savannah, proceeded to Fernandina, etc.

Captain McCorkle holds that the advantages of inland navigation along our whole Atlantic and Gulf coast are of the first importance; and the object of this paper is to bring the matter before the public in a substantial shape. Both the Government and syndicates undertake large surveys that do not promise a tithe of the advantages that would accrue to a large number of the people of these United States from this great water connection.

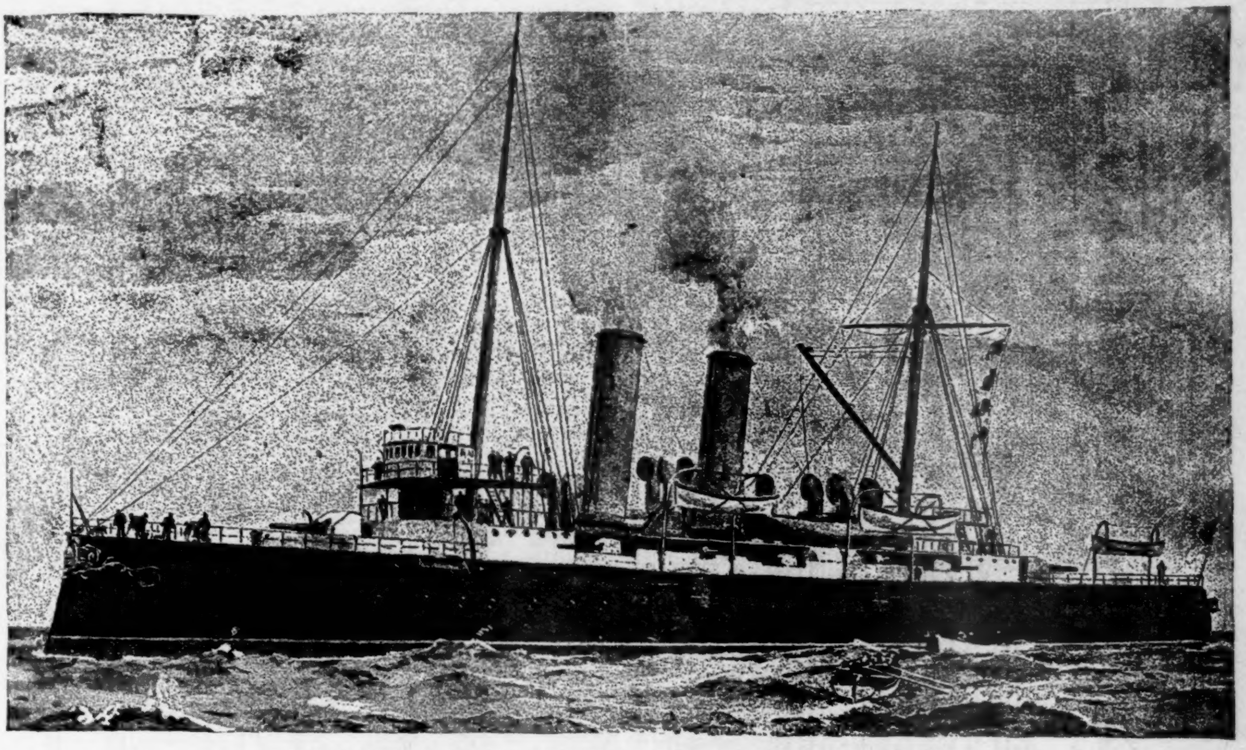
THE ENGLISH FAST CRUISER "EDGAR."

THE engraving given herewith shows the *Edgar*, one of the latest type of first-class fast cruisers built for the English Navy. The ship was built at Devonport, and the engines have been built by the Fairfield Ship-building & Engineering Company, of Glasgow, and have just received their trials.

The *Edgar* is an unarmored cruiser, and her general dimensions are: Length, 360 ft.; beam, 60 ft.; mean draft, 23 ft. 9 in.; displacement, 7,350 tons. She is of steel, with a double bottom, and has a protective deck extending the entire length, and varying from 2 in. to 5 in. in thickness. The engines and boilers are further protected by the arrangement of the coal bunkers. Outside of this there is no armor except that on the conning-tower and the gun shields.

The armament consists of two 9.2-in. 22-ton guns, placed on the upper deck, on center-pivot mounts, one forward and one aft; ten 6-in. rapid-fire guns, on center-pivot mounts, six on the upper deck and four in casements on the main deck. All these guns are protected by shields of 6-in. compound armor plates. The secondary battery includes twelve 6-pdr. and four 3-pdr. rapid-fire guns and seven fire-barrel Nordenfelt guns. There are also four torpedo-tubes, two opening above and two below the water-line.

The ship has a full equipment of electric lights, including search-lights. She is provided with artificial ventilation, water condensers and all the usual appliances.



THE FIRST-CLASS CRUISER "EDGAR," BRITISH NAVY.

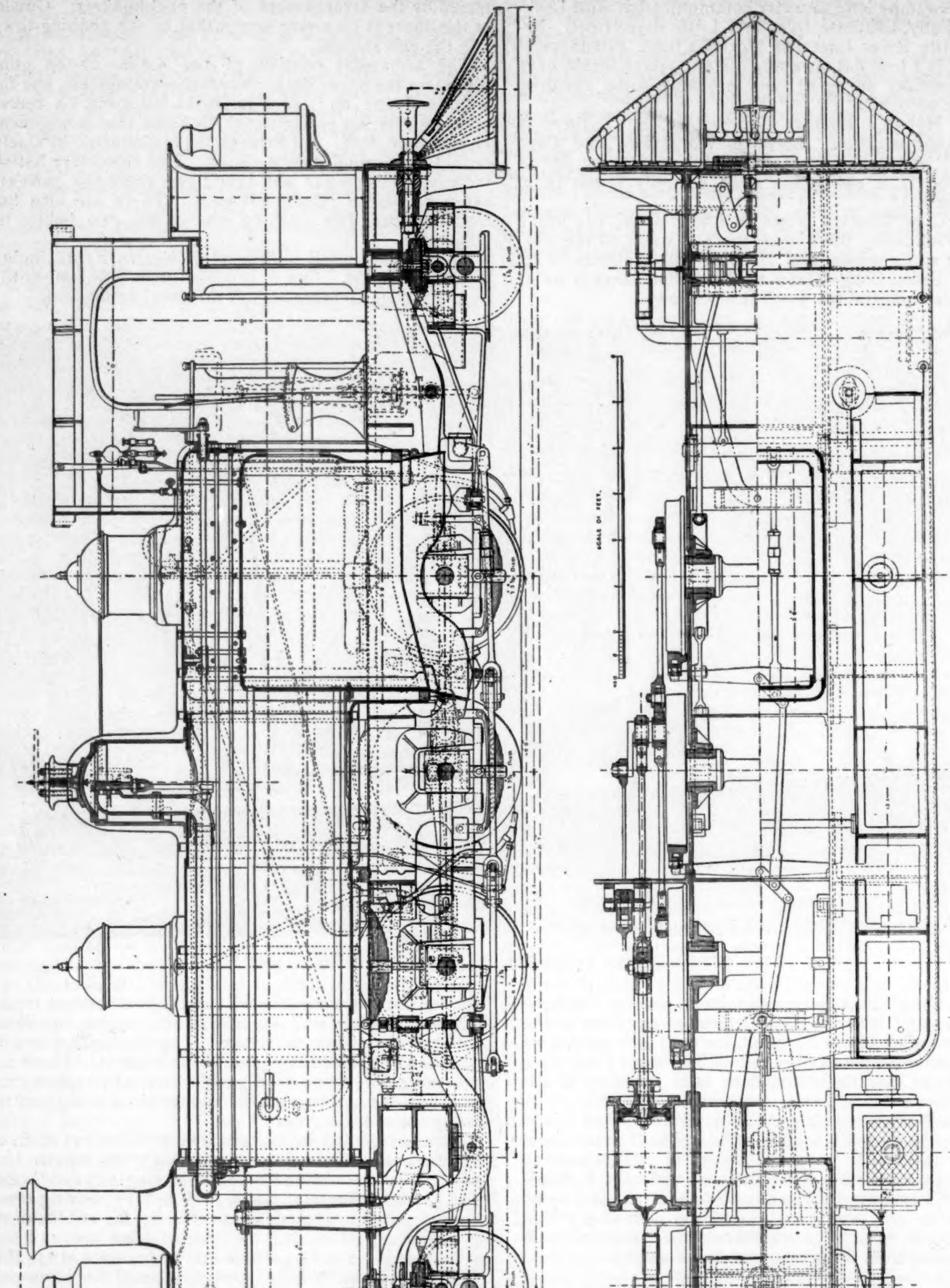
There are two screws, each driven by a vertical triple-expansion engine, with cylinders 40 in., 59 in. and 88 in. in diameter and 51 in. stroke. The condensers are of brass, and are placed alongside of the engines. There are circulating, bilge and feed pumps driven by separate engines. There are also small engines for starting and reversing the main engines.

Steam is supplied by four double-ended boilers 16 ft. in diameter and 18 ft. long, each with eight corrugated furnaces 3 ft. 9 in. in diameter, and one single-ended boiler 12 ft. 11 in. in diameter and 9 ft. 3 in. long, having three furnaces. The total grate area is 868 sq. ft., and the heating surface 25,411 sq. ft.; the ratio of grate area to heating surface is 1 : 29.26. The working pressure is 155 lbs.

The coal capacity is 850 tons on normal displacement, which gives the ship a cruising range of about 3,000 knots at full speed and of 10,000 knots at a 10-knot speed.

On the trial trips the engines of the *Edgar* developed 10,178 H.P. with natural draft. With forced draft, on a four hours' trial, they averaged 13,101 H.P., and gave the ship an average speed of 20.97 knots an hour. The boilers gave much more satisfactory results than in some other ships lately tried, showing no signs of weakness under forced draft. The artificial draft is on the closed stokehold system.

The cruisers of which the *Edgar* is a type are lighter vessels than the *New York* of our own Navy, having no armor belt. They might rather be classed with the fast cruiser No. 12, having nearly the same displacement,



TANK LOCOMOTIVE FOR NEW ZEALAND GOVERNMENT RAILROADS.

although they are 50 ft. shorter. The *Edgar*, moreover, has only two screws, and about two-thirds the engine power of No. 12. The *Edgar's* armament is also somewhat heavier in caliber, as the 9.2 in. guns are heavier than any No. 12 will carry. The two ships will have about the same cruising range, but No. 12 is expected to be the faster boat.

The *Edgar* has two masts, with fore-and-aft rig; there are no fighting tops. She is a very handsome vessel in appearance, the lines being fine, while the ship is free from the various erections on the upper deck with which some of the French cruisers are disfigured.

ROLLING STOCK FOR NEW ZEALAND RAILROADS.

In the accompanying illustrations, for which we are indebted to *Industries*, figs. 1 and 2 show the type of locomotive designed by Mr. J. P. Maxwell for the New Zealand Government Railroads. A perspective view of the engine was given in the February number of the JOURNAL, page 82; and some account of the railroads themselves was also given in the March number, page 113. The roads are of 3 ft. 6 in. gauge.

The engine, which was built at the shops at Christchurch, New Zealand, under charge of Locomotive Superintendent T. F. Rotherham, is intended to work a light traffic at moderate speeds over heavy grades. It has six driving wheels, a two-wheeled truck forward and another at the rear end, and is arranged to run in either direction without turning. Water is carried in two side tanks, and coal in a box on the foot plate.

The boiler is of Lowmoor iron plates $\frac{7}{16}$ in. thick, the barrel being 42 in. in diameter. The fire-box is of the Belpaire type, and the inside fire-box is of copper. The working pressure is 160 lbs.

The driving wheels are $39\frac{3}{4}$ in. in diameter, and are spaced 4 ft. 3 in. apart, the total fixed wheel-base being 8 ft. 6 in. The distance from center of forward drivers to forward truck is 7 ft.; from rear drivers to rear truck, 6 ft. 9 in., making the total wheel-base 22 ft. 3 in. The trucks are of the swing-bolster type, with $28\frac{1}{2}$-in. wheels and outside bearings. The springs of the forward drivers and the front truck are equalized, as are those of the four rear drivers and the rear truck.

The cylinders are 14 in. in diameter and 20 in. stroke; they are placed outside, with the steam-chests on top. The valve-gear is outside, and is of the Walschaert type. Balanced valves are used.

The frames are of steel $\frac{7}{8}$ in. thick, 3 ft. $0\frac{1}{4}$ in. apart, and the bogie frames are of the ordinary bar type. All the wheels, with the exception of the drivers, which are flangeless, are fitted with a water service, which is in constant use, and has given excellent results. Two pairs of wheels are fitted with Gresham & Craven's sanding apparatus. Care has been taken to reduce as far as possible the time and labor which constant attention to lubrication necessitates, and where possible all working parts are supplied from oil reservoirs, so situated that the syphons can easily be drawn when lubrication is not required, while the cylinders are fed from a sight-feed lubricator placed in the cab. Piston rods and valve spindles are provided with metallic packing. Two influx injectors are carried, one on each tank, the waste water being carried down to the ash-pan.

The ash-pan is fitted with perforated doors and dampers. The smoke-box requires no special mention, except that the chimney (which is in one piece), the smoke-box front, and door are of cast iron.

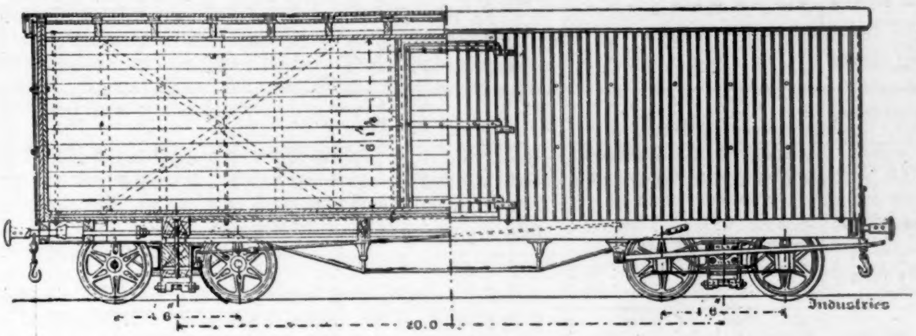


Fig. 3.

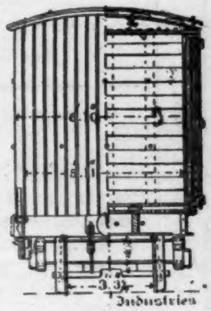


Fig. 4.

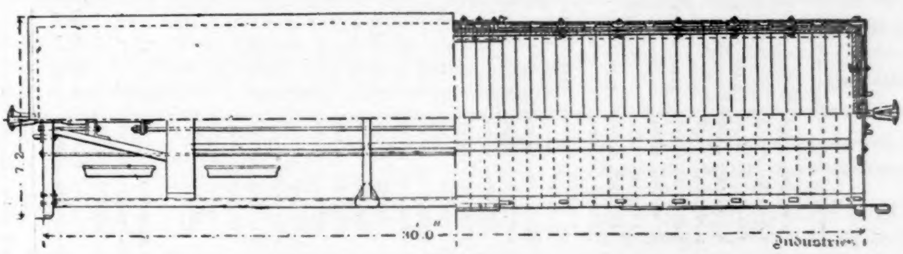


Fig. 5.

BOX CAR FOR NEW ZEALAND GOVERNMENT RAILROADS.

The brake gear on these engines is worthy of notice. It can be applied either by hand or steam, both acting on one and the same lever. A single adjusting nut only is required, and one great advantage in this gear lies in the fact that a new block may be placed on any one wheel without necessarily renewing the others, and without needing any adjustment.

This engine has been working for some time over grades as high as 160 ft. to the mile, and curves of 330 ft. radius, some of these being reverse curves, and the working load up this incline is 125 tons, exclusive of its own weight. The weight of this engine, with tanks and bunkers full and in complete working trim, is 36 tons, distributed as follows: $5\frac{1}{4}$ tons on each truck axle, leading and trailing, and $8\frac{1}{2}$ tons on each coupled axle.

The car, shown in figs. 3, 4 and 5, is an eight-wheel box car of the American pattern. It is of a class built especially to carry meat. It is 30 ft. long over all; 7 ft. 2 in. extreme width; 6 ft. 10 in. wide outside box, and 5 ft. 11 in. inside, the side sheathing being double. It is 6 ft. 1 in. high in the clear, inside. The trucks are 20 ft. between centers; each has four 26-in. wheels, the axles being spaced 4 ft. 6 in. apart.

The stock cars are of very similar construction, the only difference being that they have open siding and different doors. The sheep cars are provided with a second deck. Small four-wheel cars are chiefly used for ordinary freight.

LOCOMOTIVE RETURNS FOR THE MONTH OF DECEMBER, 1891.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Top. & Santa Fé	593	477	....	....	353,563	2,082,786	4,368	....	....	....	....	....	87.30	....	....	6.01	7.24	0.29	0.20	6.59	1.64	21.97	....	...	1.59
Canadian Pacific	577	....	479,707	1,050,885	290,965	1,821,557	3,157	....	....	....	....	...	72.10	....	....	3.45	13.00	0.42	....	5.44	1.21	23.52	....	2.04	3.56
Chic., Burlington & Quincy	....	479	....	....	....	1,844,115	3,850	5.01	17.69	....	....	....	90.78	....	....	7.78	6.46	0.22	0.38	6.96	...	21.80	....	...	1.41
Chic., Milwaukee & St. Paul	801	...	....	....	....	2,536,016	3,166	...	....	....	....	....	80.26	....	...	4.47	8.43	0.27	....	6.86	....	20.03	....	...	2.05
Chicago & Northwestern	846	....	661,517	1,449,401	662,406	2,773,324	3,278	....	....	....	....	....	87.83	....	....	3.37	8.60	0.38	...	6.27	0.82	19.44	...	....	1.94
Cleve., Cinn., Chic., & St. L.	....	444	413,951	664,316	358,461	1,436,728	3,236	4.40	21.30	73.70	118.13	64.80	92.00	16.75	5.54	2.84	5.97	0.19	1.76	6.56	0.22	17.54	....	....	1.28
Cumberland & Penn.	22	20	5,660	34,523	....	40,183	2,009	....	....	....	....	....	86.96	....	.	10.60	4.60	0.50	....	....	...	17.50	....	....	1.09
D., L. & W., M. & E. Div.	....	156	152,341	292,203	15,800	460,344	2,951	....	....	...	....	....	62.73	....	...	4.11	9.78	0.33	....	6.00	....	20.22	....	....	3.07
Hannibal & St. Joseph	42	42	49,309	92,586	27,212	169,107	4,026	4.76	15.17	....	....	....	85.77	17.72	6.54	2.60	5.76	0.14	0.27	6.11	...	14.88	...	....	1.48
Kan. City, F. S. & Mem.	145	....	102,614	236,901	127,688	467,203	3,222	...	....	...	...	....	64.66	...	....	2.66	5.60	0.21	0.63	7.10	...	16.20	....	....	1.68
Kan. City, Mem. & Birm.	41	39	37,691	60,354	7,041	105,086	2,695	....	....	....	....	....	69.18	....	...	3.15	3.83	0.86	...	6.97	....	14.79	....	....	1.06
Kan. City, St. J. & C. B.	44	41	58,868	43,448	40,524	142,840	3,247	5.00	19.75	...	....	....	65.32	13.45	4.46	9.72	5.52	0.13	0.28	5.59	....	21.24	....	....	1.99
Lake Shore & Mich. South.	560	....	425,953	917,063	589,093	1,932,109	3,450	....	....	....	...	....	69.20	....	....	2.78	5.51	0.16	....	7.10	0.18	15.73	....	....	1.58
Louisville & Nashville	...	350	428,679	818,568	371,135	1,638,382	3,601	5.17	15.37	64.48	106.53	49.37	83.53	12.56	6.94	4.33	6.79	0.26	1.43	6.14	0.60	19.55	3.28	1.56	1.82
Manhattan Elevated	...	272	784,465	....	65,325	849,970	3,124	....	....	...	....	....	44.24	....	....	2.10	8.80	0.30	....	8.60	....	19.80	....	....	3.96
Mexican Central*	146	119	....	....	....	397,223	3,332	...	....	...	....	....	68.40	....	....	5.00	17.55	0.45	0.19	5.87	0.95	30.01	....	....	5.60
Minn., St. P. & S. S. M.	....	....	69,183	164,851	19,080	253,114	....	3.95	15.22	...	....	....	76.62	....	....	4.11	13.15	0.23	....	6.10	....	23.59	....	2.12	3.26
Missouri Pacific	339	300	....	....	....	1,120,801	3,736	4.50	17.08	...	....	....	89.97	15.75	6.95	4.23	6.65	0.32	1.38	6.28	1.28	20.14	4.15	1.38	1.46
N. Y., Lake Erie & West.	...	617	450,052	1,119,823	325,447	1,895,322	3,072	4.60	21.10	89.90	131.10	66.10	....	19.60	6.20	4.81	7.62	0.40	2.70	7.17	1.06	23.76	....	1.75	1.38
N. Y., Pennsylvania & Ohio	....	261	149,929	477,078	140,020	767,027	2,939	5.00	17.40	78.90	115.10	70.40	....	15.90	6.60	4.16	6.53	0.32	3.00	6.74	1.03	21.78	....	1.85	1.30
N. Y., Ontario & Western.	113	101	....	....	....	271,269	2,686	....	...	...	....	....	108.30	...	....	4.30	9.80	0.40	....	6.00	0.80	21.30	....	....	2.18
N. Y., Prov. & Boston	....	90	103,776	52,404	64,740	220,920	2,455	...	....	...	....	....	54.37	....	....	2.93	9.71	0.50	...	6.30	0.89	20.93	....	....	....
Old Colony	....	220	338,358	128,374	131,441	598,173	2,719	....	....	...	....	....	59.65	....	....	2.94	11.94	0.62	....	6.78	0.81	23.09	...	....	4.00
Philadelphia & Reading	....	....	451,282	804,953	550,761	1,806,996	....	....	....	....	....	....	87.33	....	...	3.99	4.73	0.30	....	5.77	0.38	15.17	....	....	......
South. Pacific, Pacific Sys.	....	700	....	....	....	1,670,778	2,387	....	....	...	....	...	61.69	....	....	5.04	19.22	0.25	1.91	7.31	1.81	35.54	....	....	5.83
Wabash	399	359	420,404	785,138	277,438	1,482,980	4,131	4.79	18.25	69.06	108.40	58.00	87.76	14.55	5.93	2.90	4.88	0.29	....	6.22	0.79	15.08	2.69	0.94	...
W.N. Y. & Penn., S. G. L.	....	123	90,588	168,442	71,000	330,050	2,684	....	....	...	....	....	77.52	...	....	2.62	3.88	0.32	..	6.55	...	13.37	....	....	1.00
" " N. G. L.	....	6	8,119	4,330	2,310	14,758	2,460	...	....	...	....	....	47.51	....	....	3.48	2.38	0.27	....	6.16	....	12.29	....	....	1.00
Wisconsin Central	156	120	138,908	268,500	59,316	466,725	3,889	...	....	...	....	....	82.07	....	....	2.99	10.50	0.24	....	7.00	....	20.73	....	....	2.82
Year ending Dec. 31, 1891.																									
Atchison, Top. & Santa Fé	794	701	....	....	3,763,707	23,742,607	33,870	...	....	....	....	....	80.42	....	....	4.93	7.11	0.35	0.16	6.69	1.49	20.73	....	....	1.71
Canadian Pacific	....	577	5,696,371	9,972,669	3,071,439	19,840,479	33,762	....	....	...	....	....	63.94	....	....	3.92	11.49	0.41	...	5.31	1.26	22.39	....	2.01	3.56
Cumberland & Penn	28	24	....	65,495	384,227	449,722	18,738	....	....	....	....	....	83.33	....	....	11.30	4.50	0.40	....	...	2.00	18.20	...	....	....
Kan. City, St. Jo. & C. B.	45	45	703,428	512,937	427,797	....	36,537	4.49	19.49	....	....	....	58.11	12.32	3.87	3.67	5.45	0.17	0.48	6.00	....	15.77	....	....	2.04
Missouri Pacific	....	300	....	....	....	12,490,140	41,634	5.20	12.24	....	....	....	80.39	14.23	6.39	4.56	6.01	0.36	1.34	6.34	1.27	19.88	4.06	1.44	1.45

* The Mexican Central Railway reports 16.8 units of work per $1 of expenses; 167.6 units of work per ton of coal; 11.9 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

THE UNITED STATES NAVY.

THE experiments on cellulose have been carried out at the Indian Head proving ground. They consisted in firing projectiles through boxes or tanks filled with cellulose and then submerging the tanks in water, the object being to test the extent to which this material will protect the sides of a vessel when pierced by shot. One of the cases was filled with the material in the ordinary way; in the other the cellulose was packed in small water-proof bags. The results have not yet been reported.

THE new cruiser *Raleigh* was to be launched at the Norfolk Navy Yard March 31. The *Raleigh* is an unarmored steel twin-screw cruiser, 300 ft. long, 42 ft. wide, 18 ft. mean draft and 3,083 tons displacement. The other cruiser of this class, the *Cincinnati*, is under construction at the New York Navy Yard.

IT is not probable that many new ships will be authorized by Congress this year. The Senate Naval Committee has reported in favor of building two new battle ships, two coast defense vessels, five light draft gunboats and light torpedo-boats; but the House Committee's bill as prepared only authorizes one new ship, an armored cruiser of the same type as the *New York*. The result may be a compromise, but it does not seem likely that much addition will be made to the House plan.

THE E. W. Bliss Company in Brooklyn, N. Y., which is making the auto-mobile torpedoes ordered by the Navy Department, will begin the delivery during the present month, and it is stated that there will be no delay after that in completing the contract.

GENERAL BERDAN has submitted to the House Committee on Naval Affairs plans for a vessel 260 ft. in length, 40 ft. beam, and about 2,400 tons displacement, to be armed with an enormous submarine gun carried in the bow below the water-line. His vessel is, in effect, a gigantic torpedo-boat, and his object is to destroy a ship by running his vessel as close to it as possible and firing under water. The plan is not altogether a new one. The proposed ship bears some resemblance to the Ericsson submarine boat, and General Berdan himself has been trying to draw attention to it for a number of years past.

VENTILATING THE BALTIMORE TUNNELS.

THE Pennsylvania Railroad Company, at the suggestion of Mr. George C. Wilkins, General Agent, has decided to establish a system of tunnel ventilation in connection with the tunnels of the Company in Baltimore. Mr. William H. Brown, Chief Engineer of the Pennsylvania Railroad system, has made an examination of the difficulties to be overcome, and plans have been prepared for the necessary appliances. It is proposed to erect a ventilating stack and fan midway over each of the long sections of the Baltimore & Potomac and the Union Railroad tunnels. The fans will be operated by electricity from a central power-house, located near the North Avenue end of the Bolton Yard. This power-house will be 40 × 60 ft. in area. It will be a neat brick structure, with one end of timber covered with corrugated sheet iron, so that this end can be removed and the building enlarged if necessary. The plant will include an engine, four boilers, a generator and the necessary electrical apparatus. The currents for the operation of the fans will be conducted by wires, which can be run through the tunnel or above ground to the ventilating shafts. From this central power-house it is also intended to light the tunnels by electricity.

The ventilation will be accomplished by building a slanting subway 8 ft. wide by 16 ft. high from the side of the tunnel, near its top, to the foot of the ventilating stack, which, on account of the heavy foundation necessary, will be located at the side of the tunnel. At the foot of the stack a huge fan fashioned like the blades of a steamboat propeller will be revolved on a vertical shaft, creating a strong draft toward the top of the stack. The vacuum created at the middle of the tunnel will cause the smoke and gas to be drawn from the ends of the tunnel to its middle, and out of the top of the stack. The stacks are to be 100 ft. high and 18 ft. square. They will be ornamented with panelings of brick, and with belt courses of terra cotta and covered with a top coping of light-blue stone. Adjoining each stack a small ornamental brick house will be erected for the storage of oil and materials used in operating the system.

Owing to the smoke and gas being thrown off at such a great height, and also by reason of the fan being practically noiseless, through the use of electricity, the disagreeable features are reduced to a minimum, so that the persons living near the stacks will be subject to very little annoyance. By this system it is said the tunnel will be cleared of smoke and gas in less than two minutes after the passage of a train, so that when another train enters the tunnel will be clear. The car windows will not have to be closed as at present, and the feeling of suffocation now experienced in passing through the tunnel will be obviated.

THREE-RAIL TURNOUTS FOR DOUBLE-GAUGE TRACKS.

BY JAMES K. GEDDES, C.E.

A LARGE percentage of the railroad mileage of this country is now standard gauge, and much of the remaining mileage will before long be changed to the standard.

In many foreign countries, however, especially in Mexico and in the Central and South American States, the gauges of the railroads are far from uniform, with but little apparent inclination to better the state of affairs as the many new lines are projected and built.

Thus, in Chili the following are the railroad gauges, with mileage, as given in Poor's Manual for 1890—viz.:

Gauge 2 ft. 6 in.	miles operated	273
" 3 ft. $3\frac{3}{8}$ in.	" "	56
" 3 ft. 6 in.	" "	185
" 4 ft. 2 in.	" "	98
" 4 ft. $8\frac{1}{2}$ in.	" "	390
" 5 ft. 6 in.	" "	747
" not given	" "	474

Some of the other South American States have nearly or quite as great a diversity.

In 1885, of the railroads of the world, 74 per cent. of the mileage was of 4 ft. $8\frac{1}{2}$ in. gauge, and 26 per cent. of other gauges.

Even in this country there are many mountain and local lines that will not warrant a change of gauge till there is a radical change in the volume of traffic.

These lines for the most part (as to mileage) of 3 ft. or of meter gauge commonly have at least one terminus at some point reached by the standard gauge, and the transfer of freight and passengers from the one to the other is commonly a matter of much expense and annoyance. More particularly is this the case where the narrow-gauge line forms a branch of some standard-gauge line.

To facilitate such a transfer of business, it is now common to lay a third rail on the tracks in terminal yards, so that narrow and standard-gauge rolling stock can be used in such yards in common.

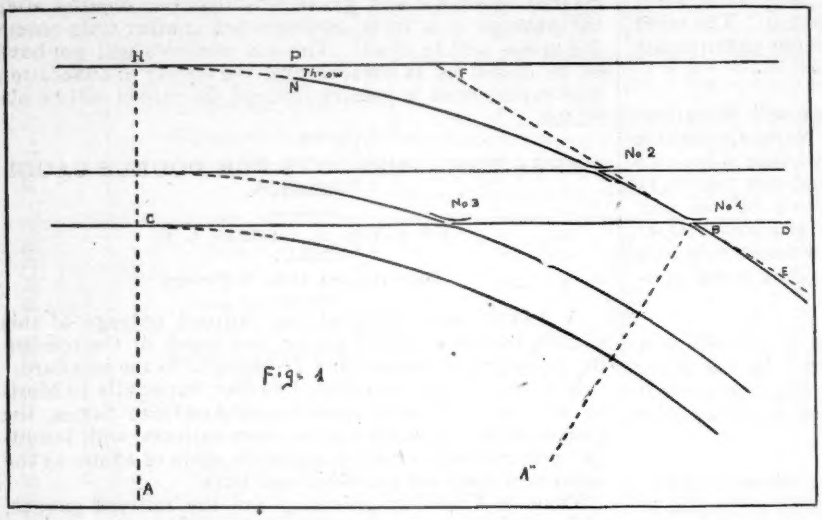
To lay such a third rail necessitates the putting in of *three-rail turnouts;* such turnouts are expensive, both in the cost of the frogs and other switch fixtures, as well as in the labor required in putting them in. Creditable practice requires that at least two of the frogs in a complete three-rail turnout should be curved to suit the respective alignments of the main track and the turnout. Every change in the radius of the turnout curve or in the alignment of the main track of course necessitates the use of a different set of frogs. Likewise a different set must be used when the turnout is to the right or to the left, or when the switch is a trailing or a facing switch, even though the respective alignments remain the same.

Thus a turnout from a tangent to the right requires a different set of frogs from a like turnout to the left; and a facing switch from a tangent requires a different set from that of a

trailing switch, though the frog numbers may be the same; in a way analogous to the manner in which a glove for the right hand is different from one for the left hand.

While the problems connected with three-rail turnouts are quite simple, and readily calculated by the use of plane trigonometry, they are commonly confusing from the large number of cases that present themselves.

It is the purpose in this paper to discuss the manner of the ready solution of such problems as are likely to be presented to the engineer. To this end formulas for such cases are deduced, and, to further simplify the matter, numerous numerical examples are given. From the formulas and numerical examples thus given, it is believed that the engineer may, without difficulty, find just what he may want, and readily apply the proper formulas to any particular case.



It may be noted that while the formulas are primarily prepared for the solution of three-rail turnouts, many of them are equally applicable to all the cases that are likely to occur for ordinary turnouts, not only from tangents but from curves as well.

In the following discussion the turnout curve will be regarded as a circular curve, that representing the outer rail $H B$, fig. 1, being tangent to the line $F H$ and $F B$, these tangents being of equal length where H represents the heel of the switch and B the point of the frog.

This method of regarding the turnouts will be found to agree as closely with actual practice as other methods in vogue, and, besides, has the merit of simplicity.

In this connection, it may be remarked, that for ordinary turnouts, Parsons, in his "Turnouts," regards the turnout curve as circular.

In the case of three-rail turnouts, we commonly have the gauges, the alignment of the main track and that of the turnout given to find the length of the throw rail, the frog angle and the length of the chord, or the arc from the heel of the switch to the point of frog; or we have the alignment of the main track, one of the frog angles and the gauges, to find the length of the throw rails, the radius of the turnout, the remaining frog angles and the length of chord or arc from the heel of the switch to the point of the frog.

TURNOUTS FROM A TANGENT.

We will first consider turnouts from a tangent.

Length of Throw Rails.—To find the length of throw rails, it is only necessary to determine the length of the chord $H N$, fig. 1, having given the throw $P N$ and the radius of the turnout curve.

Letting D equal the chord deflection, or twice the throw, C, the length of chord required, and R, the radius, Henck (Prob. 18) shows that $d = \frac{c^2}{R}$, whence we have:

$$c = \sqrt{R\,d}. \qquad (1)$$

Example:

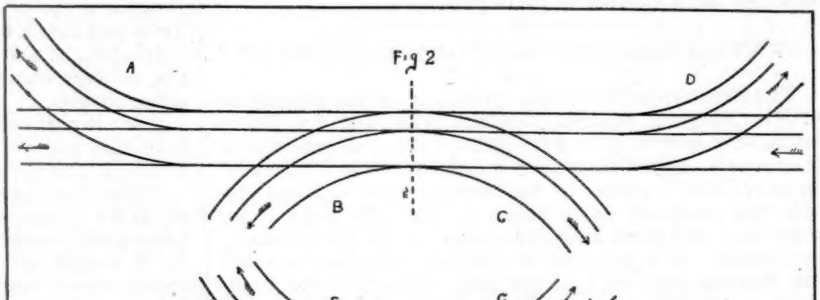
Let the throw be 5 in. and the radius 762.75. Required the chord length of the throw rail.

Twice the throw = 10 in. = 0.833 ft.	$\bar{1}.9206450$
$R = 762.75$	2.8823822
Extracting sq. root	2)2.8030272
$C = 25$ ft. $2\frac{1}{2}$ in. $= 25.206$	1.4015136

In common practice there may be eight cases of turnouts from a tangent, as follows:

1. Turnout to the right, with third rail on the right of center, facing switch A, fig. 2.
2. Turnout to the left, with third rail on the right of center, facing switch B, fig. 2.
3. Turnout to the right, with third rail on the right of center, trailing switch C, fig. 2.
4. Turnout to the left, with third rail on the right of center, trailing switch D, fig. 2.
5. Turnout to the left, with third rail on the left of center, facing switch E, fig. 3.
6. Turnout to the right, with third rail on the left of center, facing switch F, fig. 3.
7. Turnout to the left, with third rail on the left of center, trailing switch G, fig. 3.
8. Turnout to the right, with third rail on the left of center, trailing switch H, fig. 3.

These eight cases are reduced to four, for it may be readily shown that the switch A, fig. 2, is identical with that at H, fig. 3; that the switch at B, fig. 2, is identical with that at G, fig. 3; that the switch at C, fig. 2, is identical with that at F, fig. 3, and that the switch at D, fig. 2, is identical with that at E, fig. 3. We will therefore consider the first four cases only.



In this connection it may be remarked that there may be cases in which the third rail may be placed in the center of the track—a condition not likely to occur in practice; and these will not be considered further than to say that they may be disposed of in a manner analogous to that employed in the other cases.

CASE I.

We will now consider Case I.

First let it be required to find the frog angle $D B E$, fig.

4, of the first frog, given the radius R, the standard gauge g and the narrow gauge g'.

The frog angle $D\,B\,E$ is equal to the central angle

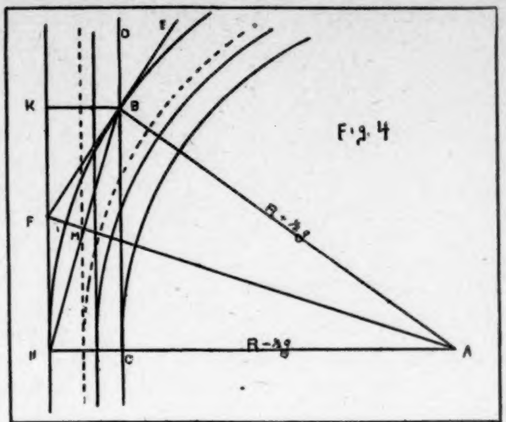


Fig. 4

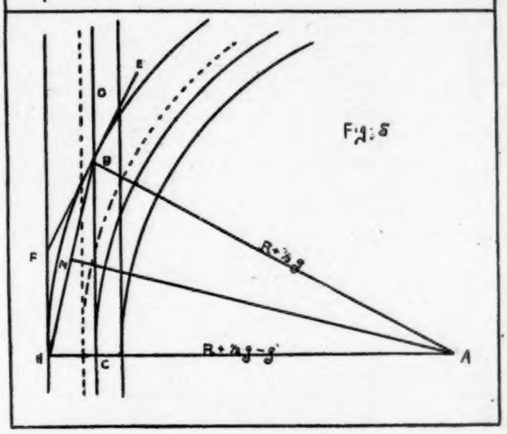


Fig. 5

$B\,A\,C$. For we have $D\,B\,E = F\,B\,C$, and since both are right angles, we have $F\,B\,A = B\,C\,A$. We find that

$$F\,B\,A = A\,B\,C + F\,B\,C$$
$$B\,C\,A = A\,B\,C + B\,A\,C$$

from which we have

$$B\,A\,C = F\,B\,C = D\,B\,E.$$

From a further inspection of fig. 4, it is evident that the distance $A\,H = A\,B$. From the center of the turnout curve to the outer rail of the turnout is equal to $R + \frac{1}{2}g$.

It is likewise evident that the distance $A\,C$ from the center of the turnout curve to the inner rail of the turnout is equal to $R - \frac{1}{2}g$.

Since $A\,C$ is perpendicular to $B\,C$, we have given the sides $A\,B = R + \frac{1}{2}g$ and $A\,C = R - \frac{1}{2}g$ of the right-angled triangle $A\,B\,C$ to find the angle $B\,A\,C$. By trigonometry we have

$$\text{Cos. } B\,A\,C = \frac{R - \frac{1}{2}g}{R + \frac{1}{2}g}. \qquad (2)$$

Example:

Given $R = 762.75$ and $g = 4$ ft. $-$ $8\frac{1}{2}$ in. $= 4.708$ to find the frog angle $D\,B\,E = B\,A\,C$, fig. 4:

$R - \frac{1}{2}g = 760.396$ 2.8810398
$R + \frac{1}{2}g = 765.104$ 2.8837205

$B\,A\,C = 6°\ 21'\ 34''$ .... *cos.* 9.9973193

To find the frog angle of the second frog $D\,B\,E$, fig. 5.

It may be shown, in a like manner to that just shown, in the first section of Case I, that the frog angle $D\,B\,E$ is equal to the central angle $B\,A\,C$.

In this case $A\,B$ must be again equal to $R + \frac{1}{2}g$, but $A\,C$ is here equal to $R + \frac{1}{2}g - g'$.

Likewise we again have the sides of the right-angled triangle $A\,B = R + \frac{1}{2}g$ and $A\,C = R + \frac{1}{2}g - g'$ to find the angle $B\,A\,C$.

We now have

$$\text{Cos. } B\,A\,C = \frac{R + \frac{1}{2}g - g'}{R + \frac{1}{2}g}. \qquad (3)$$

Example:

As an example, let there be given $R = 762.75$, $g = 4$ ft. $-$ $8\frac{1}{2}$ in. $= 4.708$ and $g' = 3$ ft. to find the frog angle $D\,B\,E = B\,A\,C$, fig. 5.

$R + \frac{1}{2}g - g' = 762.104$ 2.8820143
$R + \frac{1}{2}g = 765.104$ 2.8837205

$B\,A\,C = 5°\ 4'\ 31''$ .... *cos.* 9.9982938

To find the frog angle of the third or double-pointed frog, fig. 6.

Again, we have the frog angle $D\,B\,E$ equal to the central angle $B\,A\,C$.

Here $A\,B$ is equal to $R + \frac{1}{2}g - g'$ and $A\,C = R - \frac{1}{2}g$.

Then in the right-angled triangle $A\,B\,C$ we have $A\,B = R + \frac{1}{2}g - g'$ and $A\,C = R - \frac{1}{2}g$, from which

$$\text{Cos. } B\,A\,C = \frac{R - \frac{1}{2}g}{R + \frac{1}{2}g - g'}. \qquad (4)$$

Example:

As in the last two examples given, let $R = 762.75$, $g =$ 4 ft. $-$ $8\frac{1}{2}$ in. $= 4.708$, and $g' = 3$ ft. to find the frog angle $D\,B\,E = B\,A\,C$, fig. 6.

$R - \frac{1}{2}g = 760.396$ 2.8810398
$R + \frac{1}{2}g - g' = 762.104$ 2.8820143

$B\,A\,C = 3°\ 50'\ 13''$ ... . *cos.* 9.9990255

To find the radius of the turnout curve:

When the conditions are that it is desired to find the

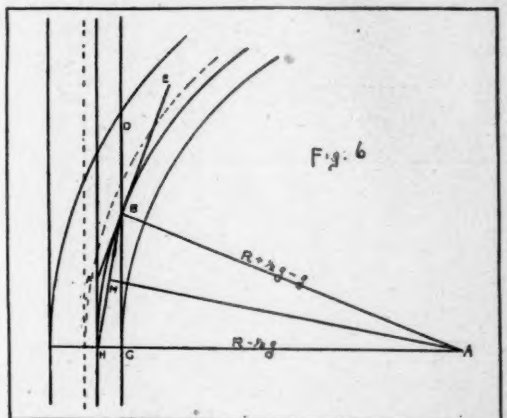


Fig. 6

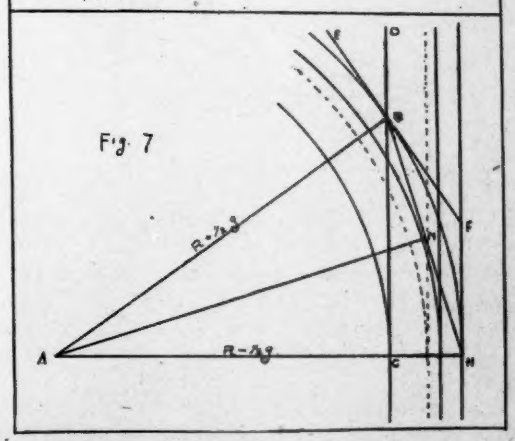


Fig. 7

radius, the gauge and the frog angle being given, we may proceed as follows:

In fig. 4 let $D\,B\,E = K\,F\,B$ and $K\,B = g$. Then in the right-angled triangle $K\,F\,B$ the tangent

$$F\,B = \frac{g}{\text{sin. } K\,F\,B}. \qquad (5)$$

Now, in the right-angled triangle $A\,B\,F$ there are given the three angles and the side $F\,B$, from which

$$R + \tfrac{1}{2}g = F\,B \times \text{Cot. } B\,A\,F. \qquad (6)$$

Example:
Given the frog angle $= 6^\circ\ 21'\ 34''$ and the gauge $= 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ to find the radius $= R$, fig. 4.

$g = 4.708$	0.6728365
$K F B = 6^\circ\ 21'\ 34''$ .... *sin.*	9.0444045
$F B = 42.504$	1.6284320

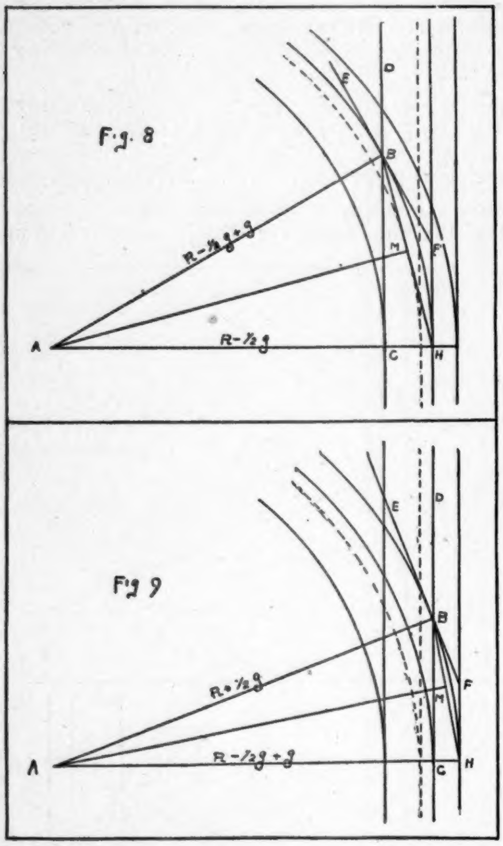
Thus, having found the tangent $F B$, we make use of equation 6.

$F B = 42.504$	1.6284320
Cot. $B A F = 3^\circ\ 10'\ 47''$	1.2552872
$R + \frac{1}{2} g = 765.102$	2.8837192

Subtracting the $\frac{1}{2} g = 2.354$ from this result, we have as the radius 762.748.

To find the length of the chord $H B$, fig. 4, from heel of switch to point of frog:

In the triangle $A B M$ we have the angle $B A M = \frac{1}{2}$



$B A C$, since $A M$ bisects the chord $H B$. Then, since $A B = R + \frac{1}{2} g$, we have from trigonometry the $\frac{1}{2}$ chord

$$B M = R + \tfrac{1}{2} g \times Sin.\ B A M. \qquad (7)$$

Example:
Given $R = 762.75$, $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ and the angle $B A M = \frac{1}{2} B A C = 3^\circ\ 10'\ 47''$, to find the chord $H B$, fig. 4:

$R + \frac{1}{2} g = 765.104$	2.8837205
$B A M = 3^\circ\ 10'\ 47''$ .... *sin.*	8.7440436
$B M = 42.439$	1.6277641

whence $H B = 84.88 = 84$ ft. $10\frac{1}{2}$ in.

In a similar manner the chord length may be found for any case.

To find the length of the arc from the heel of the switch to point of frog:

If it be desired to find the length of the arc measured along the outer rail of the turnout curve from the heel of the switch to point of frog, we may proceed as follows:

Represent the angle $B A C$, fig. 4, by a and the radius $A B$ by r.

Then the whole arc of the circle of which r is the radius is equal to $2 r \pi$, and the part of the arc included by the angle a must be given by the equation

$$\text{Arc } B H = 2 r \pi \frac{a}{360^\circ}. \qquad (8)$$

Example: Let

$a = 6^\circ\ 21'\ 35''$,
$r = 765.104$.

Then

$2 r = 1530\ 208$	3.1847505
$\pi = 3.1416$	0.4971499
$6^\circ\ 21'\ 35'' = 22895''$	4.3597406
$360^\circ = 1296000''$ ar. comp	3.8873950
84.925 ft. = 84 ft. $11\frac{1}{8}$ in.	1.9290360

In a similar manner the length of an arc along the outer rail from the heel of the switch to the point of frog may be found for any other case.

CASE II.

We will now consider the second case, where the facing switch is to the left, with the third rail on the right.

To find the frog angle of the first frog $D B E$, fig. 7:

As in Case I, we will first consider the determination of the frog angle $D B E = B A C$, fig. 7, of the first frog, given the radius $= R$ and the standard gauge $= g$.

In the right-angled triangle $B A C$, fig. 7, we have given the sides $A B = R + \frac{1}{2} g$ and $A C = R - \frac{1}{2} g$ to find the angle $B A C$. By trigonometry we have

$$Cos.\ B A C = \frac{R - \frac{1}{2} g}{R + \frac{1}{2} g}, \qquad (9),$$

which is identical with equation (2), where the turnout is to the right. The frog angle in both these cases is, therefore, the same, and if the turnout is made a tangent from B toward E, the frogs in either case will be the same. If, however, the turnout is continued through the frog, both should be curved to the radius of the turnout curve, one to the right, the other to the left.

To find the frog angle of the second frog $D B E$, fig. 8:

For the second frog angle $D B E = B A C$, fig. 8, we have in the right-angled triangle $B A C$, $A B = R - \frac{1}{2} g + g'$ and $A C = R - \frac{1}{2} g$, and from trigonometry we have

$$Cos.\ B A C = \frac{R - \frac{1}{2} g}{R - \frac{1}{2} g + g'}. \qquad (10)$$

Example:
Given $R = 762.75$, $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ and $g' = 3$ ft. to find the frog angle $D B E = B A C$, fig. 8:

$R - \frac{1}{2} g = 760.396$	2.8810398
$R - \frac{1}{2} g + g' = 763.396$	2.8827499
$B A C = 5^\circ\ 4'\ 52''$ .... *cos.*	9.9982899

In this particular example, the difference between this frog angle and that of the turnout to the right is so small that it may be neglected in practice. However, while the frog angles are practically the same, the frogs are different, in that one must be curved to the right and one to the left, to the radius of the turnout curve.

To find the frog angle of the third or double-pointed frog, fig. 9:

We here have in the right-angled triangle $B A C$, $A B = R + \frac{1}{2} g$ and $A C = R - \frac{1}{2} g + g'$, whence

$$Cos.\ B A C = \frac{R - \frac{1}{2} g + g'}{R + \frac{1}{2} g}. \qquad (11)$$

Example:
Given $R = 762.75$, $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ and $g' = 3$ ft., to find the frog angle $D B E = B A C$, fig. 9:

$R - \frac{1}{2} g + g' = 763\ 396$	2.8827499
$R + \frac{1}{2} g = 765.104$	2.8837205
$B A C = 3^\circ\ 49'\ 45''$ .... *cos.*	9.9990294

CASE III.

Let us now consider Case III., where the turnout is a trailing switch to the right C, fig. 2.

If the turnouts B and C of like radius have their "heel" in common, as $m\ n$, fig. 2, and the part of the figure to the right of $m\ n$ be made to turn about the axis $m\ n$ for 180°, the turnout C must correspond with that of B, and therefore the frog angles, chord length, length of lead, and length of throw rail for Case III are the same as for Case II. It must be observed, however, that the frogs are curved in opposite directions.

CASE IV.

In a similar manner it may be shown that the frog angles, chord length, length of lead and length of throw-rail of the trailing switch to the left, D, fig. 2, are the same as these for A, fig. 2; Case I, it being here observed also that the frogs are curved in opposite directions.

It will thus be seen that, having calculated the functions for the turnouts for any one of the particular cases discussed, the results, so far as required by practice, will answer for any of the other cases, care only being taken to have the frogs curved in the required direction. As before observed, the first frog need not be curved at all. The second and third should be properly curved in all cases. The second frog can only be curved in two ways for all the cases discussed, while the third or double-pointed frog may be curved in four different ways.

(TO BE CONTINUED.)

A FORTIFIED RAILROAD STATION.

(From *Indian Engineering.*)

In plan the station at Lahore is a parallelogram, the interior space between the two sides through which the line passes being entirely covered in with corrugated iron roofing resting on iron trusses arranged in two spans; the inner ends of these trusses rest on a central line of pointed arches on piers; the outer ends on the walls of the station premises in line with the platforms.

There are two platforms; that for the up train service is on the left (west) side, and the other for down traffic on the right (east) side.

In prolongation of these, and on the south down line end, outside the station, are the troop sidings with their necessary platforms.

Four sets of rails pass through the station—two on the up and two on the down-line side, so that through working can conveniently be maintained even when the regular trains are at rest within the station.

The entrances to the station premises (carriage porches and passages) are placed in or about the center of the two sides, and communication across line, with the two platforms, is by means of an overhead bridge opposite to—*i.e.*, in line with—these main entrances.

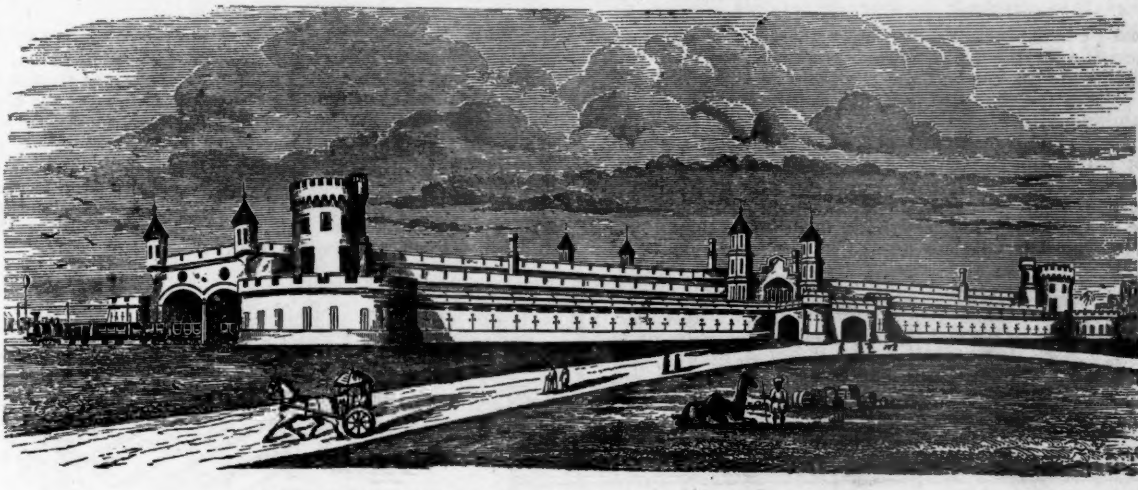
On the east (down line) platform are placed the Station Master's, booking, telegraph, and kindred offices; as also the refreshment rooms, waiting rooms, and other subsidiary accommodation for the convenience of passengers; while the greater portion of the accommodation on the west (up platform) side is appropriated to the use of the Manager's and Traffic Department offices.

Sheltered accommodation for third-class passengers is also provided within the premises, alongside the main entrances.

The illustration represents the exterior of the western face of the station (on which side is situated the civil station and City of Lahore) as also the train approaches from the north (or Peshawar) direction.

The building is of brickwork; that in the works added in recent years for the defense of the premises being of an exceptionally good quality. The style of building on the interior faces is similar to that in the other older stations on this (the Northwestern) line, such as Phillour, Umballa Cantonment, and the Shaharanpore station.

The defensive arrangements are clearly shown in the illustration. These consist of bastions at the angles with "keeps," or towers, above them; which command the several approaches and provide for a flanking defense of the curtains or outsides of the station, which also are loopholed for musketry fire over the surrounding neighborhood. This fire can be further strengthened from the several towers and turrets which overlook and command all surroundings in the immediate vicinity of the station.



FORTIFIED RAILROAD STATION AT LAHORE, INDIA.

These defensive arrangements appear to be all that is necessary to secure the station against an attack with small arms only or against a sudden rush, and further to provide for the refuge of the railroad staff and others in any time of danger.

There, however, appears to be no provision whatever for readily closing the end or train approaches; and in this respect the arrangements seem to be deficient, for in the absence of any kind of bullet-proof screens across these openings, those occupying the platforms would be exposed to considerable risks in any determined musketry attack directed against the north or south ends of the premises.

Of course the openings could, in case of emergency, be blocked up with impedimenta about the place; but at such a time rapid ingress and egress would become all the more important, and this would be seriously interfered with by resort to such a measure.

Falling shutters, or drawbridges, with proper counterweight arrangements would possibly be suitable for this purpose, and if these were provided and loopholed with the addition of a deep broad trench in front of these openings (which could be spanned by iron girders for train service), then the Lahore station would certainly be fairly well secured against any attack from without not supported by artillery.

Hodges' Steel Car.

THE accompanying illustrations show plans for the construction of a steel car prepared by Mr. H. C. Hodges, President of the Detroit Lubricator Company. In the drawings fig. 1 is an elevation of a car 70 ft. in length built to carry through freight; fig. 2 shows one end of a floor-frame, showing sills and the manner of connecting studding to the sills; fig. 2*a* shows a corner detail; fig. 3 shows a cross-tie and brace detail; fig. 4 shows in section the fastening of a stud to the side sill; fig. 5 shows a connecting fillet; fig. 6 shows in detail the fastening of the cross-tie to the middle sills; fig. 7 is a sectional elevation of a portion of a car, the figure representing two of the three trucks upon which the car rides; fig. 8 is a plan view showing at different parts of the figure the roof, the roof-frame, the floor-sills, and continuous draw-bar.

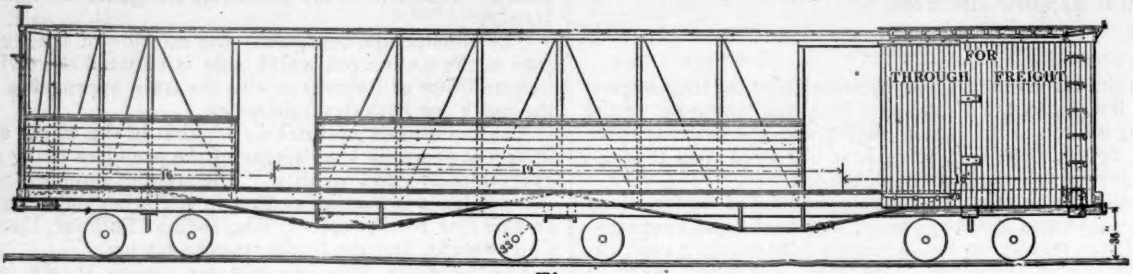


Fig. 1.

HODGES' STEEL FREIGHT CAR.

This method of car construction has for its object the construction of cars, both passenger and freight, of greater length, strength and carrying capacity than those now in use, without a corresponding increase in weight. This is accomplished by the use of a metal frame throughout, made up in the following manner: The side sills are formed by two steel channel-bars with their concave faces toward each other. The uprights are also channel steel, and are secured to the side sills by interposed cross-filling blocks (malleable iron), with the horizontal arm embedded within the channel of the side sill, and the vertical arm within the channel of the upright. It will be seen that when this joint has been completed, each part has a bearing against another part, and the bolts or rivets holding these parts together are relieved of all strain or shear. The center sills are compound channel or Z-bards, with crossed tie-plates placed between the flanges of the upper and lower members, also additional tie-plates extending above and below the central sills, and all secured to the side sills. The double central middle sills are rectangular in form, with middle flanges on either side, and are made continuous, extending from end to end, the lower halves passing under and beyond the end sills, thus forming a continuous draw-bar made integral with the car frame, and to which the draw-bars are attached. The end of the car is preferably made octagon or bay shape. The end sills are formed by uniting two channel or angle-plates with flanges overlapping in cross section, thus producing a double-webbed adjustable channel into which the ends of the longitudinal sills are placed and securely clamped. The corners of the car are formed by angle-plates overlapping, and secured to the side and end sills, and this also forms the corner upright, making a simple and strong combination at these points. By making the ends of the car octagon or bay shape, great additional strength is secured, with no perceptible loss in carrying capacity, and accidents incident to car coupling are practically avoided. The sides, ends, floor and lining are to be of wood. The roof is constructed of No. 22 corrugated steel plates of double thickness at each corrugation. The purlins are U shaped, and extend the entire length of the roof, with their concavities face to face with the roof channels, and are secured thereto by intermediate malleable iron filling blocks at each intersection.

There will be three trucks under this car, the frames made up wholly of steel shapes, the center truck being of the *equalizing type*, and provided with an *anti-friction parallel side motion* of simple design, and capable of adjusting itself to any curve in use on *trunk lines*. In cases where freight cars are of more than ordinary length, there may be two doors, located the same distance from the ends as on ordinary cars, thus giving every facility for loading and unloading that now exists with the common car. This plan is illustrated in fig. 1.

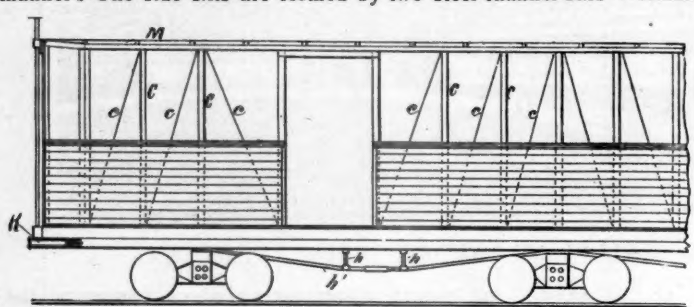


Fig 7

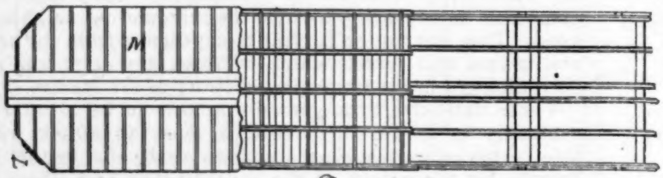


Fig 8.

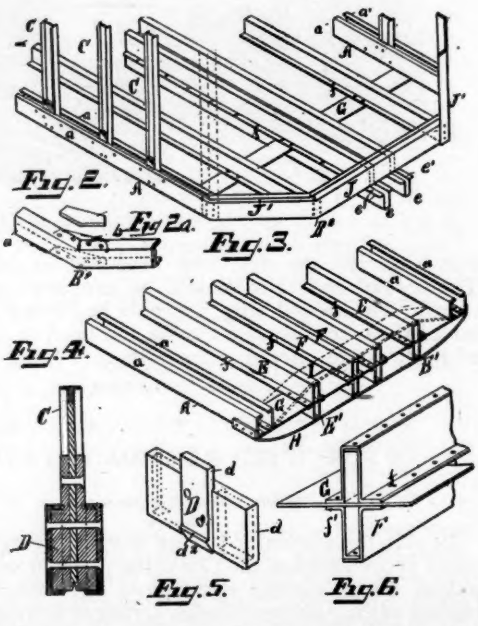


Fig. 2. Fig 2a. Fig. 3. Fig. 4. Fig. 5. Fig. 6.

Estimates relative to the cost of this construction show that it will but little exceed that of wooden cars per tonnage capacity. With slight modifications, the same methods can be applied in the construction of passenger cars, mail and express cars, and when so constructed, it is claimed that these cars will be practically invulnerable against fire and many other casualties, thereby saving loss of property and sacrifices of human lives incident to the present system of car construction, and these results can be obtained at a cost less than that of the cars actually in use.

The steel used in construction is of shapes easily rolled, and in fact commonly found on sale, so that few or no special shapes will be required in building it. While Mr. Hodges believes in the use of the long car for through business, his system of construction may be readily applied to cars of any size, while it makes the long car practicable by its additional strength.

Manufactures.

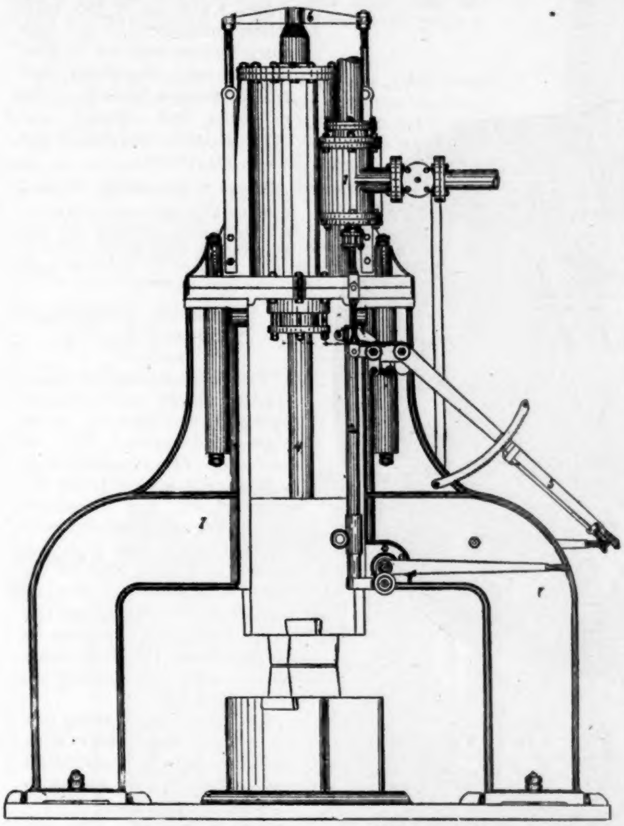
A New Steam-Hammer.

THE drawing herewith, from the *American Manufacturer*, shows a double-stand steam-hammer built by the Trethewey Manufacturing Company, of Pittsburgh.

This hammer, which is the result of much careful study, is fitted with the builders' patent balance and piston-valve, controlled by an adjustable slide-bar which is made movable to give greater or less travel to the valve as needed.

The advantages claimed for the adjustable slide-bar are:

1. The weight of the motion is carried on the stand.
2. The slide-bar can be adjusted to any angle desired.
3. By use of the slide-bar they are not dependent on the length of the ram to determine the length of the automatic stroke. The ram, therefore, can be made of any width desired.



THE TRETHEWEY STEAM-HAMMER.

For this reason work such as car axles and the like, now usually done on a helve-hammer, can be done with this hammer, made suitable for such work as well as on any other work done by a steam-hammer.

It is fitted with a handing lever by which a blow of any intensity within the compass of the hammer can be had at will.

It has a stop to protect the cylinder in case of careless running or rod breaking. All parts are easily accessible, which will be appreciated by those who have repaired steam-hammers.

All parts on which there is much wear are brass-bushed.

The ram and rod are of forged iron, and the piston-head of forged steel.

The stands are solid web, heavily flanged.

The different parts of the hammer designated by figures on the drawing are as follows: Piston-valve, 1; slide-bar, 2; ram, 3; rod, 4; handling-lever, 5; stop, 6; stands, 7.

These hammers are made in sizes from 150 lbs. upward.

General Notes.

THE Richmond Locomotive Works, Richmond, Va., are building 10 ten-wheel engines, with 19 × 24-in. cylinders, and 15 consolidation engines, with 20 × 24-in. cylinders, for the Chesapeake & Ohio Railroad.

THE contract for the new bridge over the Harlem River at Eighth Avenue, in New York City, has been let to the Passaic Rolling Mill Company, Paterson, N. J. The contract price for the bridge and approaches is $1,102,532. The plans for the structure were made by A. P. Boller.

THE Trethewey Manufacturing Company in Pittsburgh, Pa., has recently furnished the Republic Iron Company of that city with a 124 in. square shear, with engine attached. The tool weighs 35,000 lbs.

THE Jackson & Sharp Company in Wilmington, Del., has just completed an order for 25 passenger cars for the Lehigh Valley Railroad.

THE Burnham portable railroad drill was recently furnished to contractors who were building an electric railroad in Texas. One job to be done was drilling a ⅜-in. hole in each rail for the electric connection, the rails being scattered all along the line. Two men doing this work with the drill, at 2½ cents a hole, made $18 a week, which was certainly excellent work.

THE Congdon Brake Shoe Company is erecting an iron building 200 × 110 ft., which will contain a 12-ton open-hearth steel furnace and a 24-pot crucible steel furnace. It is expected that this plant will be in full operation by June next, making general steel castings and material for the Ross-Meehan brake shoes.

THE new iron steamship *Antinojenes Menendez* was launched from the Neafie & Levy yard in Philadelphia, February 27. This ship was built for Menendez & Company, of Havana, and will be used in the Cuban coasting trade. She has accommodations for 90 first-class passengers and a large cargo. Her dimensions are: Length, 238 ft.; beam, 35 ft.; depth of hold, 20 ft. 4 in.; draft, with 400 tons cargo, 9 ft. There are two compound, surface-condensing engines, with cylinders 20 in. and 40 in. in diameter and 28-in. stroke. The speed is about 13 knots an hour.

THE Pullman Car Works, Pullman, Ill., are building 85 passenger and 15 combination cars for the Philadelphia & Reading Railroad Company.

THE Lehigh Valley Car Works, at Stemton, Pa., are building 1,250 freight cars for the Central Railroad of New Jersey.

THE New York Central & Hudson River Railroad Company has let contracts for 1,000 coal cars to Murray, Dougall & Company, Milton, Pa.; 1,000 box cars to the Buffalo Car Company, Buffalo, N. Y.; and 1,000 box cars to the Peninsular Car Company, Detroit, Mich.

THE Lassig Bridge & Iron Works, of Chicago, Ill., are building two bridges for the Chicago, St. Paul, Minneapolis & Omaha Railroad. One is a bridge of two spans, each of 165 ft., over Black River at Black River Falls, and the other is an iron bridge 850 ft. long, in six spans, over the Chippewa River.

THE North Carolina Iron & Steel Company is building a new furnace at Greensboro, N. C. The stack is 70 ft. high and 14 ft. bosh, and will have a capacity of 33,000 tons a year. It will use local ores and Pocahontas coke.

THE Union Iron Works, San Francisco, Cal., have bought all the tools, machinery, patterns, etc., of the Pacific Iron Works. These will be used in extending the plant of the Union Works.

THE Egan Company, in Cincinnati, O., has made application for 20 000 sq. ft. of floor surface at the Columbian Exposition, and will show there over 40 different machines of its design and construction.

THE Detroit Dry Dock Company has contracted to build a new ferry-boat to run across the Straits of Mackinac, connecting the Duluth, South Shore & Atlantic Railroad with the Michigan Central and the Grand Rapids & Indiana railroads. The new steamer will be 300 ft. long over all, 52 ft. beam and 17 ft. draft. She will have a propeller at each end, the two screws being driven by separate compound engines. The new boat will be 70 ft. longer that the one now in use—the *St. Ignace*—but will be built in very much the same way, as that boat has had remarkable success in working through the ice, having made regular trips when she had to break through ice 3 ft. and over in thickness.

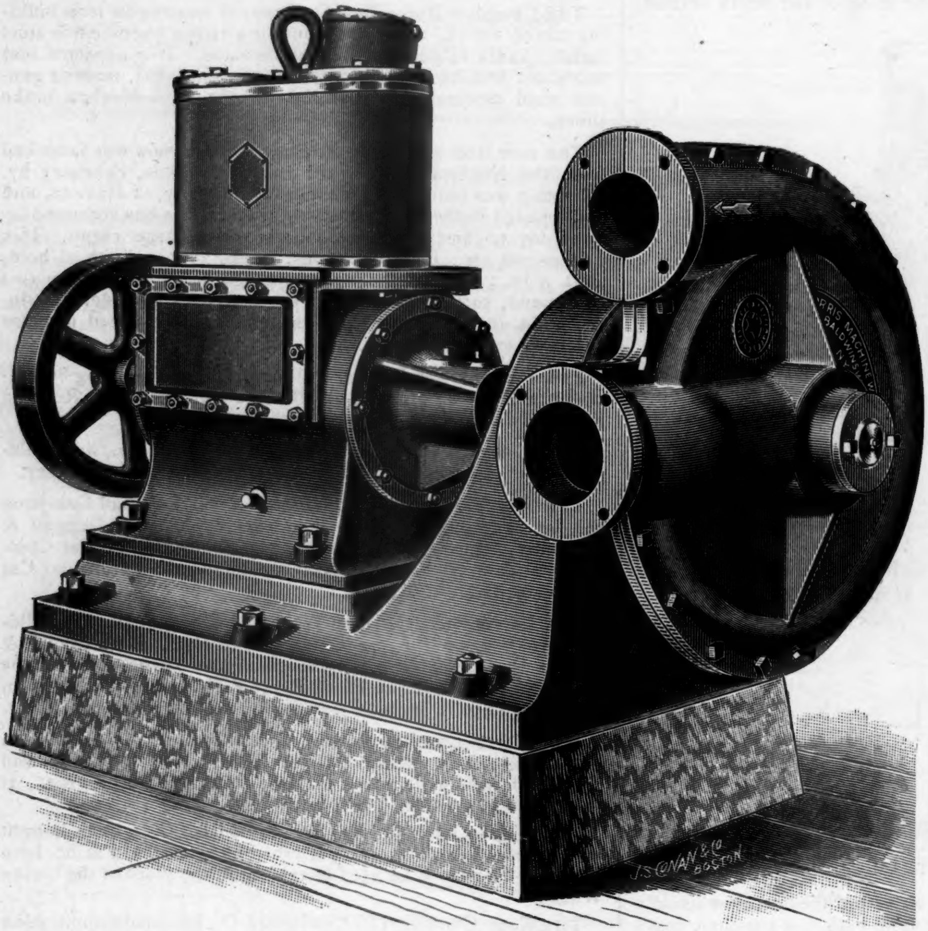
THE Buffalo Steam Forge Company has gone into the hands of a receiver. It is believed, however, that the difficulties can be adjusted and work resumed.

THE New England Engineering Company has been organized at Springfield, Mass., by William A. Harris and John Bartholomew. The new concern will contract for bridges, architectural iron work, elevators and castings of all descriptions.

THE Mexican International Steamship Company, recently organized in Philadelphia, has now completed its arrange-

ments, and will soon have a regular line in operation between Philadelphia and Mexican ports. Mr. Henry C. Ayer, of the firm of Pedrick & Ayer, is President of the Company.

THE St. Charles Car Company, St. Charles, Mo., is building 500 box cars for the Peavy Elevator Company; 200 coal cars for the Cairo Short Line, and 200 furniture cars for the Missouri Pacific. They have recently, in addition, closed contracts for 500 box and 200 flat cars for the Atchison, Topeka & Santa Fé, and for 1,000 box cars for the Missouri Pacific. The Passenger Department is now building 10 combination cars for the Lake Shore; 2 baggage cars for the Pittsburgh & Lake Erie; 3 passenger cars for the Wabash; 6 for the Des Moines & Northwestern, and 2 special circus cars for Ringland Brothers. Recent contracts, in addition to these, include 15 chair cars for the St. Louis & San Francisco Railroad and 5 baggage cars for the same road. The chair cars will have Scarritt chairs. Another contract is for 16 first-class cars for the Wabash. These cars will be 64 ft. long, will be provided with smoking-room and wash-rooms, and will be equipped with the Scarritt-Forney seat. They will be finished in mahogany and carried on 6-wheel trucks. Eight baggage cars for the same road will shortly be begun.



DIRECT-CONNECTED CENTRIFUGAL PUMP.

THE St. Charles Car Company has taken a contract to rebuild, repaint and put in first-class condition 75 narrow-gauge passenger cars for the Denver & Rio Grande; in order to do this work conveniently, a branch shop has been established at Denver, Col.

THE De La Vergne Refrigerating Machine Company has just completed one of the largest plants of this kind ever built for the Anheuser-Busch Brewing Company, in St. Louis, Mo. The capacity of this machine for refrigerating is equal to the work accomplished by the use of 500 tons of iron in 24 hours. The engine is a compound condensing engine of 600 H.P., having cylinders 32 and 64 in. in diameter and 48 in. stroke. The gas cylinders are double-acting, 24 in. in diameter and 48 in. stroke. The crank shaft is of iron 15½ in. in diameter and weighing 20 820 lbs. The machine occupies a floor space of 37 × 22 ft., and stands 28 ft. 6 in. high. Its total weight is about 175 tons. The steam engine is horizontal and the gas compressor is vertical. The two fly-wheels are 14 ft. 8 in. in diameter.

THE shops of E. P. Allis & Company, Milwaukee, Wis., are building a vertical, tandem, compound mine-pump engine for the Chaplin Mine, Iron Mountain, Mich. The cylinders measure respectively 50 in. and 100 in., with a stroke of 10 ft. The fly-wheel is 40 ft. in diameter and weighs 160 tons. The main shaft is 27 in. in diameter and the crank-pin 10 in. in diameter. The crank-shaft weighs nearly 8 tons. The beam is 32 ft. in length from center to center, and weighs 100 tons. The connecting-rod is 30 ft. in length from center to center, and 15 in. in diameter in the center. This engine is 54 ft. in height from bed plate, and is intended to work a line of 28 in. pumps against 1,500 ft. of head.

THE New York Central & Hudson River Company has decided to build extensive shops near Buffalo. They will be the largest and most important on the line, and will employ from 1,200 to 1,500 men when completed. A new town will be built up in connection with the shops, and will be named Depew. The company has bought 100 acres of land, and will begin work very soon.

THE Schenectady Locomotive Works have contracts for 100 locomotives for the New York Central.

A Combined Centrifugal Pump and Engine.

THE accompanying illustration shows a centrifugal pump driven directly by a high-speed engine. The advantages of a centrifugal pump for many purposes are well known, but in many cases they are partially neutralized where the pump is driven by a belt. In the arrangement shown the engine and pump are carried on the same bed-plate, making a very compact outfit, light for its capacity and taking up but little room.

The centrifugal pump can be used where water with solid matter in suspension has to be pumped, owing to its wide passages and the absence of valves. The arrangement shown has found favor in tanneries, where a composition pump is used to resist the ravages of the tan liquor; for circulating purposes on ship-board, and for circulating brine in freezing tanks of ice machinery; for raising sand and gravel from river beds, and conveying it ashore by means of a discharge pipe; for dredging and filling at one operation; for irrigation and drainage purposes, and for many other kinds of service. It has worked well both for small and large capacities.

The pump shown in the engraving is manufactured by the Morris Machine Works, of Baldwinsville, N. Y. The engine is the Westinghouse standard, made by the Westinghouse Machine Company, of Pittsburgh.

Albany Notes.

THE Wagner Palace Car shops at East Buffalo are very busy, every department being crowded with new work and repairs on old. Two of the finest cars ever sent out of the shops will soon be ready for inspection. One is for President Bliss, of the Boston & Albany, and the other is for President Depew, of the Central-Hudson. The shops are at work on two fine state-room cars, a class that are rapidly growing in popularity, and which are to be made a feature of the Central for the Chicago Exposi-

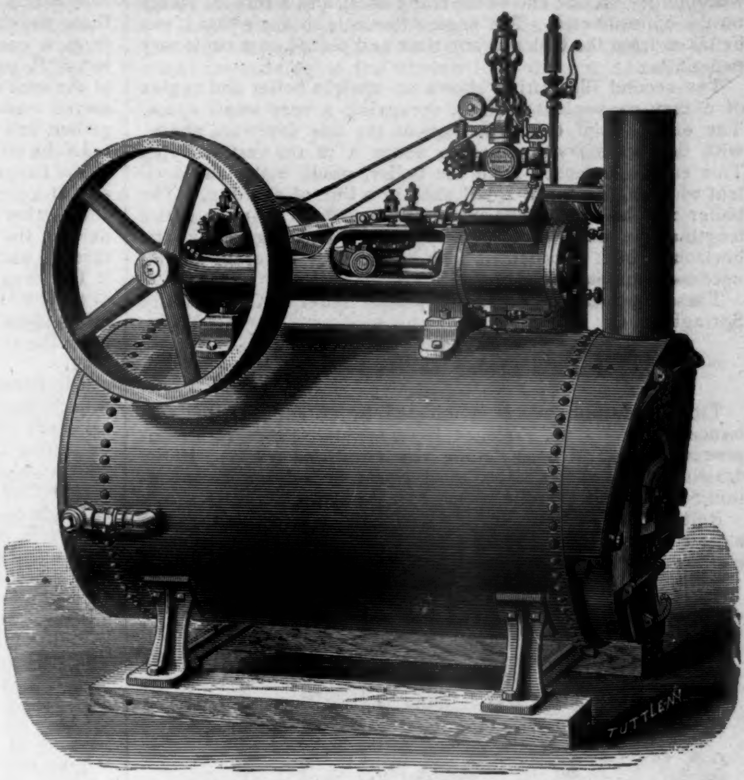
tion travel. There is now in hand in these shops also an order for thirty sleepers of the class known as "onyx columns."

THE Delaware & Hudson coach No. 53, on the Albany & Troy Belt Line, has been fitted with a system of ventilators that work upon an entirely new principle. By means of vanes on the outside of the roof a series of exhaust fans, propelled by the resistance of air when the car is in motion, forces the foul air from the interior of the car. The apparatus is the invention of W. S. Rogers, of Troy.

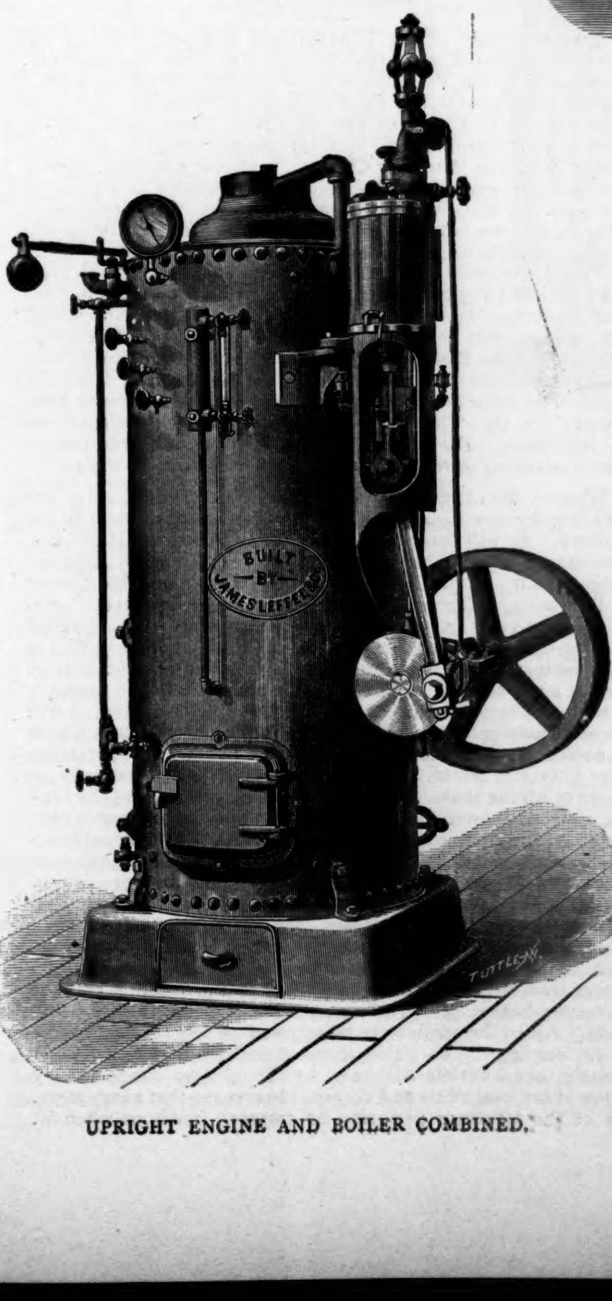
THE Albany street railroad (electric), after experiments with a hot-water heater, with furnace on the platform, has discarded it and returned to the old car stove. The inconvenience and often positive discomfort of this arrangement, however, will lead to further experiments. The man who invents a practical and cheap car heater will have a bonanza.

A BILL has been introduced in the New York Assembly providing that vehicles, except on railroads, passing over a public highway in the State, must have tires on the wheels 3 in. wide when the weight is between 2,000 and 6,000 lbs., and 4 in. in width when over 6,000 lbs. in weight.

THE railroad bills pending in the New York Legislature include an Act to require more complete fencing of roads, and the Railroad Commission bill, providing for the prohibition of grade crossings in the future. Both will probably fail this year.



PORTABLE ENGINE AND BOILER.



UPRIGHT ENGINE AND BOILER COMBINED.

Some Portable Engines.

THE accompanying illustration shows a semi-portable engine and boiler of the horizontal type. In this boiler the fire-box consists of a large cylindrical flue surrounded by water, extending the entire length of the boiler, in the front end of which is placed the furnace with a bridge-wall at back end of the grates, which are of unusual length, making a long furnace and ample grate surface. Back of the bridge wall is a combustion chamber, the entire diameter of the furnace flue, its rear end having a chamber extending upward for the return of the heated gases through a series of tubes, the length and diameter of tubes being properly proportioned to the size of the boiler. The rear end of the boiler is constructed with hinged door for the ready inspection and cleaning of that portion of the boiler; this part having a special improved fire-proof lining, which protects the head and retains the heat within the combustion chamber. The front end of the boiler has the usual fire-door and other appliances, and hinged doors permitting ready access to the ash-pit and smoke-box. The boiler is of steel.

The main frame of the engine is cast in one solid piece, and is of the class known as straight-line engine, with a center crank, and bearings on each side, which are of more ample proportions than customary. The cylinder end of the frame is turned accurately in a lathe, and the guides for the cross-head are bored out in exact line with the cylinder, making a concave surface to the guides, so as to insure the cross-head from any possible binding or heating on the sides. The cross-head is constructed with adjustable gun-metal gibs or followers. The cross-head with its pin, and the connecting rod, as also the crank shaft, are made of homogeneous solid cast steel. The cylinders are cast of carefully mixed iron, so as to insure the best results in regard to tenacity and density, as also the pistons and valves. The cylinders are covered with asbestos, with Russia iron jacket with brass band trimmings. The valve is the D slide valve, of proper proportions, adapted to the service and speed of the engines; the eccentric for operating the valve being arranged to fasten in position to crank-shaft with a cap-screw, having two holes for said screw in web of eccentric, so that by changing the screw from one hole to the other the engine is adjusted to run in the opposite direction. Each engine is supplied with throttle valve and safety governor, which insures the stopping of the engine in case of the breaking of the governor belt. The engine is supplied with a large, heavy fly-

wheel pulley on one end of the crank shaft, and a smaller pulley on the opposite end. The engine-frame is so made that it can be taken from the boiler at any time and placed on a stationary bed-plate.

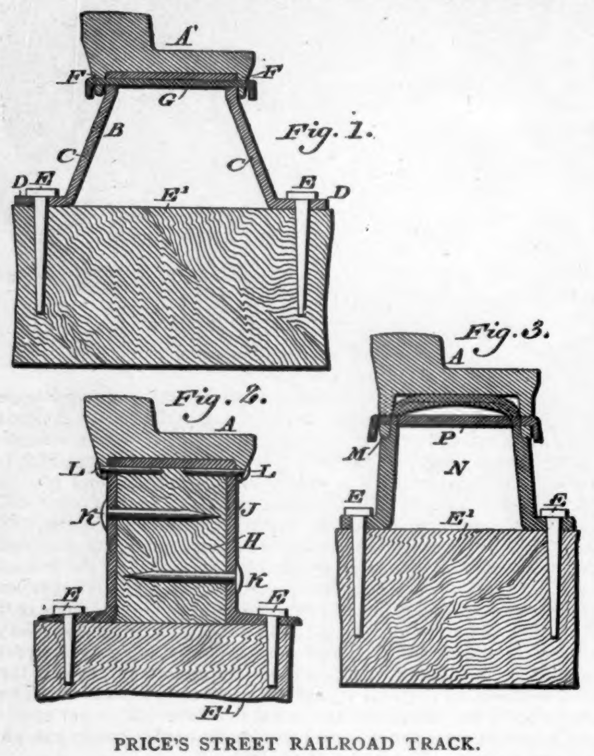
The second illustration shows an upright boiler and engine of a very convenient pattern, occupying a very small space. The engine is of the same type as the one described above, with the necessary changes to adapt it to the vertical type. This engine, detached from the boiler, would make an excellent wall engine for a small shop or a line of shafting. The boiler has the upper tube-sheet submerged, so that the entire length of the tubes is covered by water. This engine, like the horizontal one, is provided with an efficient governor and all necessary appliances.

These engines are made by James Leffel & Company, of Springfield, O.

Price's Street-Railroad Track.

THIS invention, which is covered by patent No. 469,392, issued to James M. Price, of Philadelphia, relates to an improved method of constructing street railroad tracks. In the drawings fig. 1 shows a section of a road embodying the invention; figs. 2 and 3 modified forms of the same.

Referring to the drawings, *A* designates a street rail, and *B* a chair of arched or angular shape, the latter being formed of either rolled, stamped, or cast metal, and having flaring sides *C*



PRICE'S STREET RAILROAD TRACK.

provided with horizontal feet *D*, extending outward from said chair, and adapted to be secured by the spikes *E* to a wooden or other cross-tie, *E'*.

The top of the chair is fitted closely in the under side of the rail, and both sides of the crown thereof are embraced by the depending flanges *F* of the rail, and are provided with openings, through which and other openings in the said flanges *F* are passed the metallic binding-straps *G* which pass underneath the under face of the crown of said chair, and have their outer ends bent so as to be held in place.

In the modification shown in fig. 2 a wooden sleeper, *H*, resting upon the cross-ties *E'* is inserted within a chair, *J*, which is of less thickness than that shown in fig. 1, so as to strengthen the same and thereby aid in supporting the rail *A* thereon. The sides of the said chair are provided with openings for the insertion of spikes or rails *K*, preferably cylindrical in shape, for binding the said chair to the sleeper. Passing through openings in the flanges of the rail *A* are the spikes, nails, or straps *L*, which are driven in or rest in grooves on the upper face of the wooden sleeper and directly beneath the under face of the crown of the chair. The feet of the chair are secured by suitable means to the cross-tie.

In fig. 3 is shown a section of a channeled chair having the shoulders *M* on its sides, on which rest the flanges *N* of the rail, which are lengthened and are of greater thickness than those shown in the other forms. The said chair is adapted to form a continuous passage or channel *N'*. A soft metallic strap, *P*, passing through the flanges of the rail and the sides of the arch above the shoulders, and having its outer ends hammered down outside the flanges, binds the rail and chair together, and spikes secure the feet of the chair to the cross-tie.

In the structure shown and described the holes or openings in the flanges and chair are either oblong, oval, or rectangular and of a greater length than height to provide for expansion or contraction of the construction due to heat or cold. In connecting the rails and channel-chairs broken joints are used, so that the ends of the chairs and the rails do not coincide.

The chair constructions herein shown are first rolled in lengths of from 20 to 40 ft. of their respective sections and then sawed into widths of from 3 to 5 in. except the joint-chairs, which rest upon the two cross-ties, and which should be from 12 to 24 in. long.

The strength of the arched longitudinal chair as first made is such that cross-ties may be entirely dispensed with and an excellent all-metallic structure had without sawing into chairs by resting this arched channel-rail system upon a tamped bed of Belgian block, broken stone, or its equivalent.

It will be seen that the various chairs herein described may be made of a channel bar bent into the shape indicated by suitable rolls or other devices, punched or drilled to form holes, as stated, and sawed transversely, those for the joints being double or treble the length of the ordinary chair.

Both the arched-chair and the arched-channel constructions are possessed of great strength and elasticity, and the latter breaking joints with the rails frequently fastened to it makes a very firm and smooth surface, preventing shocks at the joints.

Baltimore Notes.

THE operation of the Pittsburgh & Western Railroad has been consolidated with the Baltimore & Ohio management, thus carrying out the objects for which the Baltimore & Ohio purchased the control of the Pittsburgh & Western. It will be remembered that part of $10 000,000 of stock issued by the Baltimore & Ohio last fall was for the purchase of this road, which, with the Akron & Chicago Junction Railroad, opened last summer, constitutes the Baltimore & Ohio's new route to Chicago. A statement has been issued that it is desirable to operate the two railroads as one system, and the following officers of the Pittsburgh & Western have been appointed by order of President Oliver: J. T. Odell, General Manager; Frank Harriott, General Freight Traffic Manager; Charles O. Scull, General Passenger Agent; J. V. Patton, General Superintendent. Mr. Patton was formerly Superintendent of the Pittsburgh Division of the Baltimore & Ohio. The other appointees hold similar positions to those named in the Baltimore & Ohio service. The office of the General Superintendent will be at Allegheny City, Pa. The other officers will have their headquarters in Baltimore. The subordinates in the various departments were instructed to report to the new officers from March 15.

MESSRS. BARTLETT, HAYWARD & CO., of Baltimore, are building for the Columbian Fair the largest gas-holder in the country. It will have a capacity of 4,500,000 cu. ft. of gas. The diameter at the base of the structure will be 203 ft., and the height 230 ft., or 50 ft. higher than the Washington Monument in Baltimore. The gas-holder will be the type known as "telescopic," and will be provided with four hydraulic seals to admit of telescoping the four sections inside of one another. This is the first instance of four sections being applied in the construction of a gas-holder. In building the foundations and masonry of the brick tank in which the enormous vessel is to float, it will be necessary to excavate 57,000 cu. yds. of earth, to prepare 58,000 cu. ft. of concrete, and to erect brick masonry containing over 3,000,000 bricks. It will require nearly 8,000,000 galls. of water to fill the tank. The foundation and masonry of the tank are now completed, and upon the finishing of the water test, which is being made at present, the erection of the superstructure will be begun. The total pressure upon the foundations will equal 41,000,000 lbs., and the maximum pressure per sq. ft. will equal 5,000 lbs. The crown, or upper part of the gas-holder, will be spherical in form, and will be supported upon a permanent framework of timber erected upon the bottom of the tank. On account of the heavy strains imposed upon the gas-holder from wind pressure, the plating of the different curbs is extremely heavy, the maximum thickness in upper curb being ¾ in. All of the strains are transferred to and resisted by the guide framing. The guide framing surrounds the gas-holder entirely, and consists of heavy bridge girders connected by struts of lattice girders and diagonal braces, so that every member of the structure performs its assigned functions when at.

tacked by the wind pressure. The total wind pressure when the gas-holder is inflated and in its highest position amounts to nearly 800,000 lbs. The basis of calculation for strains was formed on a pressure of 52 lbs. to the sq. ft. of vertical surface. The pressure equals a velocity of 100 miles per hour. All of the members of the guide framing will be connected by hot driven rivets. The heating and driving of rivets will be performed by the mechanics from small suspended platforms for the upper part of the structure, nearly 200 ft. above the ground. A set of stairs will extend from the bottom to the top of the structure, so that any part of the latter may be reached during heavy snow storms by the men in charge of the gas-holder. It will require 150 cars to transport the iron work from Baltimore to Chicago. It is expected to complete the work by the latter part of the present year, so that when the World's Fair is opened the gas-holder will be in complete working order, and will not only be a monument to Baltimore industry, but also a conspicuous representation of the energy of one of the most enterprising firms of this city.

AN agreement has been entered into between the Baltimore Belt Railroad Company and the Baltimore & Ohio Railroad Company, to take effect November 1 next. The Belt Company grants the Baltimore & Ohio the right at all times to maintain connection with its tracks and to use its stations and appurtenances for transporting and delivering traffic, and for the purpose of interchanging traffic with any other railroads which may hereafter form a connection with the Belt Line. The Baltimore & Ohio agrees to ship all its traffic passing through Baltimore over the Belt Line, excepting what is destined for stations of the Baltimore & Ohio on the water front of the city, or to and from Canton. Passenger traffic is to pay a *pro rata* on actual mileage, the distance from North Avenue to Camden Station being counted as one mile. Eight-wheel loaded freight cars are to pay $1.50 each, two four-wheel cars to count as one eight-wheel car. A minimum of $250,000 of traffic receipts is guaranteed by the Baltimore & Ohio; and when that amount is exceeded, the rate on the excess is to be reduced one-half. The Baltimore & Ohio agrees to keep in repair the tracks, stations, and appurtenances of the Belt Line and to pay all taxes. If other railroads use the Belt Line, they are to pay an amount in proportion to their wheelage.

THE Baltimore & Ohio has for some time been building to connect with the Virginia Midland Division of the Richmond & Danville at Fairfax Station. The line which is to connect the two systems is the Metropolitan Southern, which is to extend from Linden Station, a short distance from Washington, on the Metropolitan branch of the Baltimore & Ohio, to Fairfax. Through traffic for points on the Richmond & Danville will be run upon the Metropolitan Branch from Washington to Linden, when the connection is established, and thence to the South by way of Fairfax. It is thought that this connection led to the rumors of the acquisition by the Baltimore & Ohio of southern railroad systems, which President Mayer has denied.

THE Carlisle Manufacturing Company is building 300 hopper gondola cars of 60,000 lbs. capacity for the Monongahela River Railroad.

The Edwards Car Window.

THE accompanying illustration shows a car window devised by Mr. O. M. Edwards, of Syracuse, N. Y., fig 1 being a perspective view and fig. 2 a section through the window casing.

The window sash is connected by a band to a spring roller of sufficient strength to lift the sash. In place of the ordinary stops on the inside of the window are two compound stops, one at either end of the sash. These stops consist of a movable section or strip enclosed by a stationary casing, to which they are connected by pivoted links so arranged that the movable section is thrown upward and outward by a spring against the sash, thus holding it firmly against the outside stops, making a tight joint and preventing the rattling of the sash. This arrangement, it is claimed, will not only exclude air and dust, but will prevent the opening of the window from without, as any force

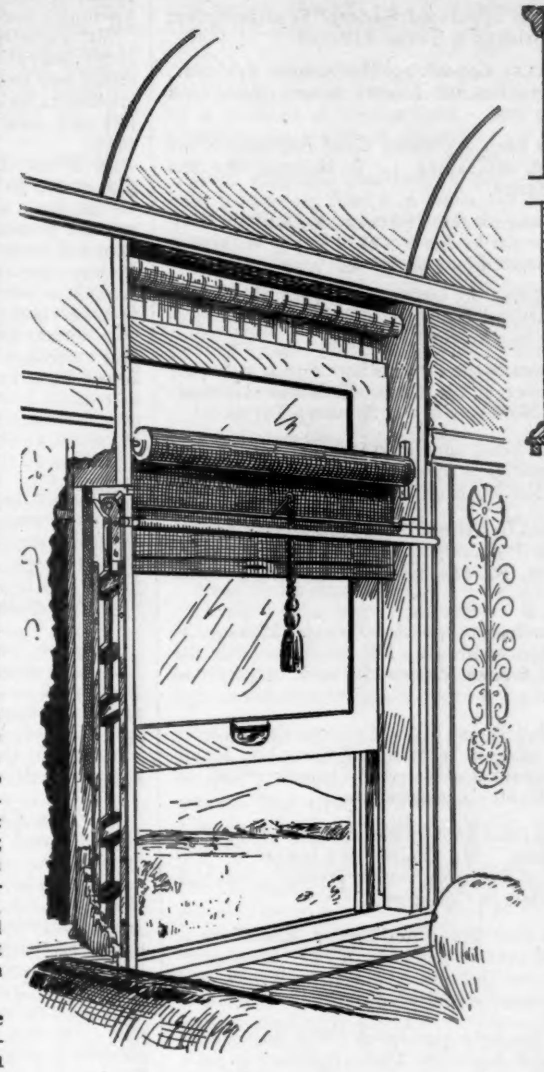


Fig. 1.

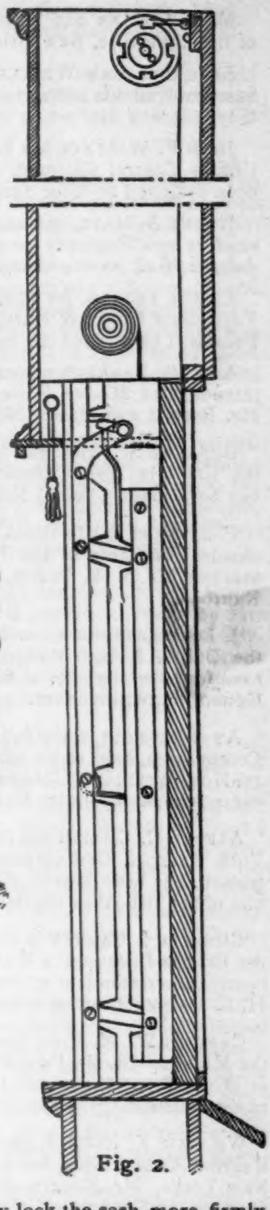


Fig. 2.

EDWARDS' CAR WINDOW.

applied for that purpose would only lock the sash more firmly. When the window is open the sash can be readily pushed down, as its friction will remove the pressure of the movable stops. These stops are connected by a rock-shaft provided with an arm midway between them, and at the top of the window, to which a tassel is attached. When it is desired to open the window all that is necessary is to pull downward upon the tassel, when the stops are lowered slightly by the rock-shaft and are thrown out of contact with the sash, thus leaving it free to be raised by the spring roller. Upon releasing the tassel the sash will be securely held at any point. When it is desired to close the window all that is to be done is to push it down by hand. The sash being held in place by the spring roller, it is not liable to fall, as the ordinary car window will sometimes do. It is claimed, moreover, that there is no chance of a failure to work, as the movable stops will give and take sufficiently to allow for any shrinking or swelling of the wood, thus preventing the sticking in wet weather, which is sometimes very annoying with the ordinary window; should any cinders or other matter become lodged inside of the sash they will fall out upon withdrawing the stops.

A trial of this window has been made on the Chicago & Alton Railroad, where a reclining chair car containing the largest sashes, 35 in. in width and weighing 30 lbs. apiece, has been fitted with this device. It has so far received general favor.

PERSONALS.

SAMUEL F. PRINCE, JR., has been appointed Superintendent of Motive Power of the Long Island Railroad.

M. B. CUTTER has been appointed General Superintendent of the Louisville, New Orleans & Texas Railroad.

FRANKLIN VAN WINKLE, Consulting Mechanical Engineer, has removed his offices to No. 126 Liberty Street, New York City.

JOHN F. WALLACE has been appointed Chief Engineer of the Illinois Central Railroad, succeeding L. T. MOORE, who has been assigned to other duties.

JULIAN A. HALL, recently on the Richmond & Danville Railroad, is now Engineer for the bridge works of Grant Wilkins in Atlanta, Ga., having charge of outside work.

LUCIUS TUTTLE, for some time General Manager of the New York, New Haven & Hartford Railroad, has been chosen Vice-President to succeed the late Edward M. Reed.

AMOS R. BARRETT succeeds the late William Smith as Superintendent of Motive Power of the Boston & Maine Railroad. Mr. Barrett was Master Mechanic of the Southern Division.

CHARLES S. PRICE has been appointed General Manager of the Cambria Iron Company, succeeding JOHN FULTON, who has been made General Mining Engineer of the Company.

E. L. MOSER, late Chief Draftsman, has been appointed Mechanical Engineer of the Philadelphia & Reading Railroad to succeed Mr. S. F. Prince, Jr., who has gone to the Long Island Railroad.

J. L. GREATSINGER has been appointed General Manager of the Duluth & Iron Range Railroad. He has been with the road for several years, at first as Master Mechanic and later as General Superintendent.

AT a meeting of the full Board of the Interstate Commerce Commission, held at its office in Washington, Saturday, March 19, HON. WILLIAM R. MORRISON was elected Chairman to fill the vacancy made by Judge Cooley's resignation.

ALFRED C. CHAPIN has been appointed a member of the New York Railroad Commission. Mr. Chapin is a lawyer by profession, has been Mayor of Brooklyn, and at present represents one of the Brooklyn districts in Congress.

CHARLES J. CARNEY is now Superintendent of Machinery of the Brooks Locomotive Works at Dunkirk, N. Y. He was recently Superintendent of the Dunkirk Engineering Works, and H. C. CROWELL succeeds him in that position.

CAPTAIN W. W. RICH has been appointed Chief Engineer of the Minneapolis, St. Paul & Sault Ste. Marie Railroad in place of W. A. FISHER, who has resigned. Captain Rich had charge of the construction of the road, but retired some time ago.

WILLIAM E. ROGERS, recently Chairman of the New York Railroad Commission, has opened a law office at 120 Broadway, New York. Mr. Rogers also announces that he is prepared to examine and report on the financial or physical condition of railroads.

DANIEL W. SANBORN has been appointed General Superintendent of the Boston & Maine Railroad, assuming the duties performed by the late General Manager Furber. GEORGE F. EVANS succeeds Mr. Sanborn as Superintendent of the Southern Division.

J. W. LATTIG, formerly Superintendent of Telegraph of the Lehigh Valley Railroad, and more recently General Superintendent of the National Switch & Signal Company of Easton, Pa., is now General Superintendent of the Electric Secret Service Company, of New York.

JUDSON C. CLEMENTS, of Georgia, has been appointed a member of the Interstate Commerce Commission, WILLIAM LINDSAY, who was previously appointed, having declined the office. Mr. Clements is a lawyer of ability, and has served in the Georgia Legislature and in Congress.

F. W. BALDWIN has been appointed General Superintendent of the Central Vermont lines, succeeding JAMES M. FOSS, who has been appointed Assistant to the President. Mr. Foss has been connected with the road for 24 years, serving successively as Master Mechanic, Superintendent of Motive Power, and General Superintendent.

H. B. LA RUE is well known to many of our readers, and a number of them have probably heard that some time ago he was summarily arrested and placed in a private asylum. Those who have not heard the result will be glad to learn that he was promptly discharged from custody as soon as the question of his sanity could be brought before the proper court.

Mr. La Rue now has his turn, and has brought suit to recover heavy damages from certain parties concerned in the affair, and from some newspapers which published sensational articles in relation to it. His complaint in the suit is very full and carefully drawn, and presents apparently a strong case.

It is not the editor's business to pass judgment on a case that is now in court; but attention cannot be called too often to the ease with which a case of insanity can be made out against a man when there is a motive for doing so. Every man has some eccentricities of speech, habit and thought, and they are generally more prominent in a man of marked individuality—who is also apt to be really saner than the rest of us. It is very easy, under our present methods, for designing persons to take advantage of this; and for that reason we may hope that such men may be forced to make full restitution for the injury done by their schemes.

OBITUARIES.

WILLIAM SEAMAN, who died in Wilmington, Del., February 26, had been connected with the New York, Lake Erie & Western, the Norfolk & Western, and the Buffalo, Rochester & Pittsburgh railroads as an Engineer, chiefly in charge of bridge work. For several years past he had been connected with the Lobdell Car Wheel Works.

CAPTAIN TUNIS A. EGBERT, who died in Elizabeth, N. J., March 12, aged 50 years, was born on Staten Island, and had been for many years employed in the management of ferries in the waters about New York. He was for 27 years connected with the New Jersey Central ferries, and for four years Superintendent of the Hudson River ferries of the New York, Lake Erie & Western Railroad.

COLONEL CARSWELL MCCLELLAN, who died in St. Paul, Minn., March 6, served in the Engineer Corps during the War, and later was Engineer in charge of construction on the St. Louis, Vandalia & Terre Haute, the St. Paul, Minneapolis & Manitoba, the Northern Pacific and other roads. For some years past he had been in Government employ as a civil engineer on the Mississippi and other river work.

CHARLES J. VAN DEPOELE, who died in Lynn, Mass., March 18, was born in Belgium, but came to this country over 25 years ago. He was one of the first engineers to enter the field with an electric motor, and was notably successful. His first electric railroad was built in South Bend, Ind., and two years later there were 13 roads equipped with his motors, and the system had been applied to other purposes in many places. In 1888 the company which he organized was consolidated with the Thomson-Houston Company, and Mr. Van Depoele had since been with the last-named corporation as Engineer of its railroad department.

JOHN F. WINSLOW, who died at his home in Poughkeepsie, N. Y., March 10, aged 82 years, was born in Lyme, Conn., and many years ago became connected with the noted firm of Erastus Corning & Company. He was for a long time manager of the extensive iron works of that firm at Troy. He early saw the importance of the Bessemer steel making process, and with John A. Griswold and A. L. Holley he introduced the process into the United States, and for a long time controlled the patents here. Mr. Winslow and Mr. Griswold furnished the money to build Ericsson's *Monitor*, and it was their influence chiefly which induced the Government to try that ship.

Mr. Winslow was for four years—1863–1867—President of the Rensselaer Polytechnic Institute. For some years past he has practically retired from business, but has served as President of the Poughkeepsie Bridge Company.

ROSS KELLS, who died in New York, March 10, aged 52 years, had secured an excellent reputation as a mechanical engineer, and had had an extensive experience on various roads. He was for some time Master Mechanic of the Pittsburgh, Cincinnati & St. Louis Railroad, and was afterward Superintendent of Motive Power of the New York, Chicago & St. Louis. He left that line to take charge of the equipment of the New York & New England Railroad, and succeeded in filling a very difficult

position with much credit to himself and with benefit to the road. Five years ago he was appointed Assistant Superintendent of Motive Power of the New York, Lake Erie & Western, and three years later was promoted to be Superintendent of Motive Power. On the Erie Mr. Kells has been actively engaged in improving the rolling stock and in preparing to secure a greater degree of uniformity in the motive power, and had just reached a point where his labors promised to result in a notable success. Mr. Kells was widely known and popular, and his death at a comparatively early age will be much regretted.

COLONEL and BREVET MAJOR-GENERAL GEORGE W. CULLUM, who died in New York, February 29, aged 83 years, was born in New York, entered the Military Academy in 1829, was graduated in 1833, and promoted to the Engineer Corps. From 1848 to 1855 General Cullum was Instructor of Practical Military Engineering at the Military Academy, except during two years, when he traveled abroad on sick leave. In 1853–54 he constructed for the Treasury Department the Assay Office in New York, after which he was employed for five years on fortifications and improvements in Charleston (S. C.) Harbor and superintended works at New Bedford, Newport, New London and New York. On November 1, 1861, General Cullum was appointed Chief Engineer Officer of the Department of the Missouri. He was Chief of Staff to General Halleck while the latter was in command of the Department of the Missouri, and also while he was General-in-Chief of the armies. He directed engineering operations on the Western rivers, was for some time in command at Cairo, and was engaged as Chief Engineer Officer in the siege of Corinth. This is but a brief summary of the services of this distinguished officer before and during the War. He received brevets of Colonel, Brigadier-General and Major-General in March, 1865, for his faithful, meritorious and distinguished services during the War, was mustered out of the Volunteer Service in September, 1866, and attained the grade of Colonel of Engineers in 1867. In 1874 he was retired from active service. General Cullum was of cultivated literary tastes. He was the author of "Military Bridges with India Rubber Pontoons," "Register of Officers and Graduates of the United States Military Academy," a translation of Duparcq's "Elements of Military Art and History," "Systems of Military Bridges of the Campaign and Engineers of the War of 1812–15 against Great Britain," "The Struggle for the Hudson," during the American Revolution, in "Narrative and Critical History of the United States," and numerous historical, geographical and biographical papers. He was a delegate to the Conference of the Association for the Reform and Codification of the Law of Nations, held at Cologne, Germany, in August, 1881, and to the International Geographical Congress at Venice, in September, 1881. He had been Vice-President of the American Geographical Society since 1874, and of the Geographical Library Association of New York City since 1880. After General Halleck's death, General Cullum married the widow of his old chief. By his will he gives a large sum for a memorial building at West Point.

PROCEEDINGS OF SOCIETIES.

American Institute of Mining Engineers.—At the Baltimore meeting the following officers were chosen: President, John Birkinbine; Vice-Presidents, Thomas M. Drown, David T. Day and John Stanton; Secretary, Dr. R. W. Raymond; Treasurer, Theodore D. Rand; Managers, H. L. Hollis, George W. Goetz and Charles Kirchhoff. Mr. Birkinbine receives the unusual honor of a second term as President.

National Electric Light Association.—At the recent convention in Buffalo, N. Y., the following officers were elected for the ensuing year: President, James I. Ayer; Vice-Presidents, E. A. Armstrong and C. H. Wilmerding; Secretary, George F. Porter.

It was decided to hold the next convention in St. Louis, in February, 1893.

American Society of Civil Engineers.—At the regular meeting, February 17, a paper on the Holland Dikes, by William Starling, was read and discussed at considerable length.

AT the regular meeting, March 2, the Secretary read a paper by Mr. E. Kuichling on Loss of Head from Passage of Water through a 24-in Stop-valve. The paper gave the results of some very carefully made experiments. It was discussed by members present.

The following candidates were declared elected:

Members: David M. Andrews, Lock Three, Ala.; Dr. Charles B. Dudley, Altoona, Pa.; Roberto Gayol, City of Mexico; Justus H. Grant, Rochester, N. Y.; H. C. Lowrie, Denver, Col.; George F. Swain, S. E. Tinkham, Boston; James Duane, New York.

Associate Members: L. W. Goddard, Grand Rapids, Mich.; Henry H. Kerr, Fort Worth, Tex.; Albert Carr, New York.

AT the regular meeting, March 16, Mr. Desmond Fitzgerald read a paper on the Boston Water Works, which was illustrated by a number of photographs. The paper was generally discussed by the members present.

New England Railroad Club.—The annual meeting was held in Boston, March 9, when the reports presented showed that the Club has now 192 members and is in a prosperous condition.

The following officers were elected: President, F. M. Twombly; Vice-President, John T. Chamberlain; Secretary and Treasurer, F. M. Curtis. These officers are all re-elected.

A discussion on Freight Car Trucks followed, which was opened by Mr. F. D. Adams and continued by other members present. In the course of the discussion the Fox pressed steel truck was described.

Northwestern Track & Bridge Association.—The annual meeting was held in St. Paul, Minn., March 11. The reports showed an increase in membership and also in interest in the meetings. The following officers were elected: President, John McMillan; Vice-Presidents, W. S. Darby and H. A. Buel; Secretary, James McCutcheon; Treasurer, J. Copeland.

New York Railroad Club.—At the regular meeting, March 17, there was a large attendance. A paper on Track, by Mr. Benjamin Reece, was read and a short discussion followed. Mr. D. M. Brady then read a paper on the Fox Pressed Steel Truck for Freight Cars. This was also discussed, and some notes of experience with freight trucks were given by members present.

Michigan Engineering Society.—The thirteenth annual meeting was held in Grand Rapids, January 20 and 21. A number of technical papers were delivered, and the following officers were elected: President, J. H. Forster, Williamston; Vice-Presidents, George L. Wells, Grand Rapids; Colonel Muenscher, Manistee; George S. C. Pierson, Kalamazoo; Secretary and Treasurer, F. C. Hodgman, Climax; Directors, Dorr Skeels, Grand Rapids; George E. Ames, Grand Rapids; William Appleton, Ann Arbor; Guy H. Carleton, Sault Ste. Marie; J. K. Yocum, Chelsea; ex-President Davis and C. S. Dennison, Ann Arbor.

Illinois Society of Civil Engineers and Surveyors.—The annual meeting was held in Chicago, January 27, and continued for three days. The first day's sessions were occupied with the reading of papers and discussions, and with the report of the Special Committee on Preparation of a Relief Map of the State for the Chicago Exposition. On the second day the President, Professor A. N. Talbott, delivered his annual address, and in the afternoon the members visited the work in progress on the Exposition.

Among the papers read were Brick for Highway Culverts, by G. W., Gastman; Qualities of Water, by D. W. Meade; State Inspection of Bridges, by E. A. Hill, and a State Bureau of Engineering, by R. E. Orr.

The following officers were elected for the ensuing year: President, S. S. Greeley, Chicago; Vice-President, J. D. Stanford, Chatsworth; Executive Secretary and Treasurer, Samuel A. Bullard, Springfield; Recording Secretary, Charles M. Rickard; Executive Committee, A. N. Talbott, G. C. Rossiter and D. W. Meade.

Virginia Association of Engineers.—The annual meeting was held in Roanoke, Va., January 15. A new constitution for the Society was proposed and considered. A number of papers were read and discussed by the members present.

The following officers were elected for the ensuing year: President, Clarence M. Coleman; Vice-President, J. H. Wingate; Directors, M. E. Yeatman, J. E. M. Humphreys, W. E. Anderson and C. G. Cushman; Secretary and Treasurer, J. R. Schick.

New Jersey State Road Convention.—This Convention was held in Trenton, N. J., January 21, on a call issued by the State Board of Agriculture. There was an attendance of about 250 from all parts of the State. Mr. Edward Burrough, of Camden, was chosen Chairman. Papers were read on the

Value of Good Roads, by Dr. James C. McKenzie; on Practical Road Building, by Robert A. Meeker, and on Experience in Road Building, by Dr. C. B. Ripley; the last-named paper recommended the use of wide tires for all vehicles carrying heavy loads. Professor Haupt made an address on the Cost of Traction on Different Classes of Roads. Mr. Bacot described the method of constructing the Telford roads on Staten Island, and Mr. J. J. Owen made some remarks on construction and repair of common roads. Mr. Owen estimated that the proper improvement of existing roads in the State would cost on an average from $2,500 to $3,000 per mile.

A committee of eight was appointed to draw up a road law to be presented to the Legislature and resolutions in favor of improved road systems were adopted.

Canadian Society of Civil Engineers.—At the annual meeting in Montreal, January 13, the annual address of the President was read, showing that there are now 656 members, and that the Society is in a prosperous condition.

The elections for the new Council resulted as follows: President, John Kennedy; Vice Presidents, Thomas Monro, W. T. Jennings, P. Alexander Peterson; Treasurer, H. Hallis; Secretary, Professor C. H. McLeod; Council, Professor Bovey, Joseph Hobson, H. G. C. Ketchum, H. N. Ruttaw, P. W. St. George, C. E. W. Dodwell, H. I. Cambie, K. W. Blackwell, C. H. Keefer, H. D. Lumsden, F. N. Gisborne, Alan Macdougall, I. D. Barnett, E. A. Hoare, F. C. Gamble.

The Gzowski Medal was awarded to D. H. Keeley, for his paper on Developments in Telegraphy. The resident members in Montreal entertained their visiting brethren at a conversazione in the new work-shop building of McGill College, which was a brilliant social gathering.

Engineers' Club of Minneapolis.—At the annual meeting, held January 7, the following officers were elected: William A. Pike, President; W. W. Redfield, Vice-President; Secretary and Treasurer, F. W. Cappelen; Librarian, A. B. Coe; Member Board of Managers of the Association of Engineering Societies, Elbert Nexsen.

Technical Society of the Pacific Coast.—At the annual meeting in San Francisco, January 15, the following officers were elected: President, John Richards; Vice-President, Luther Waggoner; Treasurer, George F. Schild; Secretary, Otto Von Geldern; Directors, H. C. Behr, George W. Dickie, W. R. Eckart, C. E. Grunsky and A. Schierholz.

Mr. Richards is a mechanical engineer; Mr. Waggoner, a mining engineer; Mr. Von Geldern, a civil engineer, and Mr. Schild a naval architect, showing that the membership of the Society is pretty well distributed.

Civil Engineers' Society of St. Paul.—At the regular meeting, March 7, John Blodgett, H. S. Crocker, and David Curtin were elected members.

Mr. C. F. Hollingsworth read an interesting paper on the Yellowstone National Park.

Engineers' Club of Philadelphia.—At the regular meeting, February 20, after some discussion on the advantages of a large building for the joint use of the various engineering and technical societies of Philadelphia, it was resolved, on motion of Mr. Carl Hering, that a committee of five be appointed to confer with other societies on the advisability of erecting a large building for their joint use.

The Tellers of Election reported the following candidates elected to membership: D. P. Bruner, Walter C. Kerr, Paul A. N. Winand, Joseph C. Wagner, Henry L. Butler, Thomas Earle, Herbert P. White, Thomas Willis Fleming.

A memorial of R. H. Lee, which had been prepared by Mr. Trautwine, was presented, and it was directed that same be incorporated in the minutes and printed in the *Proceedings*.

Mr. A. Saunders Morris read his paper on Limitations of Electric Power Transmission, which was discussed by Mr. Carl Hering, and Mr. Morris replied to a number of questions raised.

A translation of M. Bazin's paper on Flow of Water over Weirs, by Arthur Marichal and John C. Trautwine, Jr., was presented in abstract.

Engineers' Society of Western Pennsylvania.—The regular monthly meeting of the society was held in Pittsburgh, on March 15. The meeting was devoted to discussing Mr. Metcalf's paper on Smoke, read at the February meeting.

Mr. J. W. Langley opened the discussion by stating that one side of the smoke question is sometimes overlooked: that certain industries produce smoke necessarily because of the requirements of the material which is being treated. In good practice steel furnaces do not produce any large amounts of smoke; puddling furnaces, coke ovens and household fires are large producers of smoke. Next to these last is undoubtedly boiler fires—probably in Pittsburgh they equal all other causes of smoke combined, and it is to them that the coming inventor needs to direct his attention. The mechanical stoker can only be used in large establishments; small ones cannot afford them, and it is from the small ones collectively that the greatest part of the smoke comes. A smoke-laden atmosphere has one evil effect, and that is that it is mentally depressing; that smoke is injurious to bodily health has never been proved by testimony.

Dr. Daly spoke for the Ladies' Health Association upon the injury of smoke on the lungs and air passages.

Several characters of smoke consumers were then described by their representatives. After a lengthy discussion engaged in by many of the members, a Committee on Smoke Prevention was appointed, consisting of Messrs. Dempster, Johoson, Hyde, Scaife and Langley.

Western Society of Engineers.—At a meeting held in Chicago, March 2, a committee was appointed to confer with similar committees from the Chicago Electrical Society and from the Western Society of Architects. The intention is that the three committees shall complete an organization having for its object the equipment of a museum of mechanical arts with testing rooms and other facilities for teaching in connection with the Chicago University. It is understood that if the building is provided the University will assume the cost of running the school. The amount needed is about $250,000, and a large part of this has been promised.

Civil Engineers' Club of Cleveland.—At the annual meeting, March 8, the reports of the retiring officers were presented. The Secretary showed an increase of 11 members, and 14 papers were read at the meetings. The Treasurer's report showed the finances to be in good condition. The Librarian reported an increase in the number of books, and also an arrangement with the Case Library Association giving members the use of valuable reference books.

The Programme Committee presented three interesting reports: one by Professor C. S. Howe on Recent Advancement in Physics; one by F. A. Coburn, on Recent Works of Architecture, and one by A. Mordecai, on Railroad Engineering.

The following officers were elected: President, Walter P. Rice; Vice-President, Albert H. Porter; Secretary, Charles S. Howe; Treasurer, C. P. Leland; Librarian, Charles H. Benjamin; Directors, C. H. Strong and G. A. Hyde.

The retiring President, Mr. J. L. Gobeille, then delivered the annual address on the Financial Status of the Engineer.

Engineering Association of the South.—The regular March meeting was held at the Young Men's Library Association Hall, Atlanta, Ga., March 11, President A. V. Gude, of Atlanta, presiding, with 20 members and about 30 visitors present. The non-resident members and invited guests from Kentucky and Tennessee reached Atlanta Thursday evening by a special train placed at their disposal by Major J. W. Thomas, President of the Nashville, Chattanooga & St. Louis. The trip from Chattanooga over the Western & Atlantic was made in charge of Mr. Hunter McDonald, Resident Engineer of the road, and the train made numerous stops to inspect the extensive improvements on track and bridges now being carried on. These improvements comprise the building of between 20 and 30 iron bridges, the rebuilding of a large proportion of the masonry for them, the reballasting of a considerable portion of the road-bed and the beginning of the relaying of the track with heavy steel rails, which is to be gradually extended.

Friday morning was spent in visiting the principal points of interest in the city, the greater amount of the time being devoted to the inspection of the new plant of the Electric Lighting & Power Company.

At the meeting a communication was received from Mr. Octave Chanute, transmitting a prospectus of the organization of the International Congress of Internal Water-ways, and extending an invitation to attend the fifth annual meeting of this congress to be held in Paris, France, beginning on July 21.

The following were elected:

Members: Edward B. Cushing, Houston, Tex.; W. N. McDonald, Nashville, Tenn.

Juniors: Alexander H. Wood, Tracy City, Tenn.; W. T. Young, Nashville, Tenn.

Mr. Hunter McDonald then presented a paper on Steel Rails, which received very extensive discussion by Messrs. Lodge, MacLeod and Dudley. The paper gave the history, chemical analyses, rate of wheel wear, results of bending tests and of tensile tests of three steel-rails laid at different times on the Nashville, Chattanooga & St. Louis.

Mr. A. V. Gude presented a paper on the Granite Quarries of

Lithonia, Ga. The paper presented comparative results of the crushing strength of granite from the quarries at Richmond, Va., Stone Mountain, Ga., and Lithonia, Ga., and described fully the quarrying operations at Lithonia. The most interesting point brought out by the paper was the method of lifting a quarry or producing an artificial bed covering acres in extent by a single blast-hole, a method for producing an artificial bed for the floor of the quarries discovered at the Georgia quarries a few years since.

The paper was discussed by Messrs. W. C. Smith, J. K. Peebles, and T. P. Branch. Mr. Peebles presented a description of the Petersburg, Va., quarries.

Master Mechanics' Association.—Secretary Sinclair has issued a circular calling attention of members to the necessity of answering circulars of inquiry as promptly as possible.

The Committee on Compound Locomotives—the Chairman of which is Mr. George Gibbs, Mechanical Engineer, Chicago, Milwaukee & St. Paul Railroad—has issued a circular requesting members who are in position to do so to make comparative tests of compound locomotives if possible before the Convention. If they can comply they are requested to notify the Committee at once.

Master Car Builders' Association.—The Arbitration Committee requests suggestions from all interested as to changes which may be considered desirable in the rules of interchange.

The Committee on Standard Center Plates has issued a circular containing drawings of proposed standard center plates, both of malleable and of pressed steel, and requests comments from members on the proposed plans. This Committee has also submitted designs for standard stake-pockets of two sizes, with the same request.

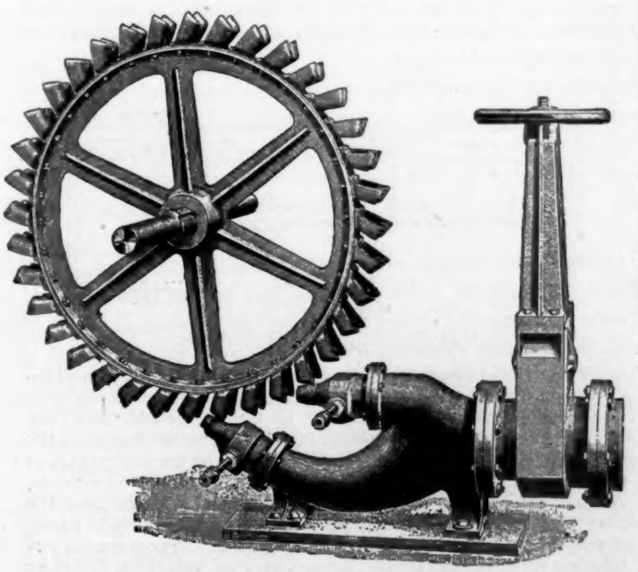
The Committee on Cast-Iron Wheels has issued circulars making inquiries as to the number of points in relation to the manufacture and service of such wheels.

The Committee on Joint Inspection also wants information as to the interpretation of a number of points in the rules, and suggestions as to changes which may be needed.

The Committee on Standards has issued several circulars, the object of which is to secure information from members as to the extent with which railroad companies generally are complying with the standards of the Association.

NOTES AND NEWS.

Double Nozzle for Tangential Water Wheels.—The Pacific Iron Works in San Francisco furnish the accompanying drawing of a recently designed double nozzle for tangential water wheels, constructed as nearly as possible to provide for the acceleration of approach, and also for application of the

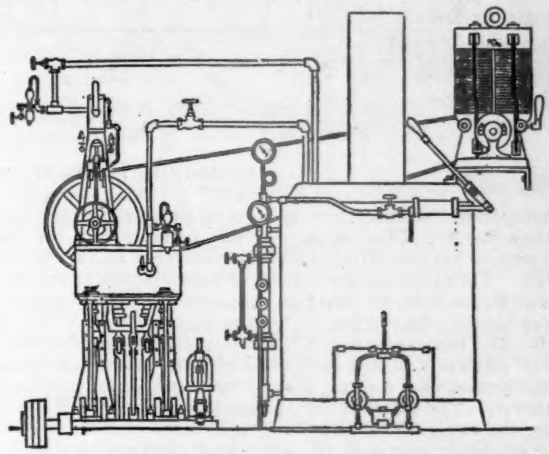


NOZZLE FOR IMPACT WATER WHEELS.

streams in such relation that they do not interfere one with the other. There is also the provision of independent control for each nozzle besides the common gate in the main supply pipe. For the rest the drawing needs no explanation, showing as it does all parts clearly, and in correct proportion.—*Industry, San Francisco.*

A Small Electric Light Plant.—The steam yacht *Cygnet* is said to be the smallest vessel ever lighted by electricity from its own plant, and was an endeavor on the part of its owners, the Shipman Engine Manufacturing Company, of Rochester, N. Y., to show how complete an equipment could be placed within the most limited space.

The vessel is 35 ft. over all and 7 ft. beam. The hull is planked with white cedar, copper riveted, and lined inside with cherry and white pine finished in oil. A Shipman oil-burning boiler supplies steam at 160 lbs. pressure to the two engines and donkey pump, all of which, together with the dynamo, are located in the cabin amidships. The main engine, which is a fore-and-aft compound engine having cylinders $3\frac{1}{2}$ and $6\frac{1}{4}$ in. with stroke of 5 in., operates its feed water and vacuum pumps by worm gear having a reduction of 4 to 1, and runs at 350 to 400 revolutions per minute. A high speed single engine is bolted to the cylinder head of the main engine as shown. This has a cylinder $2\frac{1}{2}$ in. $\times$ 3 in., and makes 500 revolutions per minute. Belted directly to the pulley of this high speed engine, and located on a bracket attached to the front of the cabin, is a $\frac{1}{2}$-kilowatt Edison generator, capable of supplying ten 16 C. P. incandescent lamps. The wiring was neatly done



YACHT ENGINE AND DYNAMO.

by Putnam, Gay & Company, of Rochester, who also arranged a search light so that when desired it can be thrown into circuit. By means of this light, it is said that the bottom of the lake can be readily seen in 40 ft. of water.

The *Cygnet* has a speed of 10 miles an hour, is fitted up with great care, and is a very comfortable craft.—*Electricity.*

Harveyized Rails.—Since August, 1891, two rails have been lying in the track of the Delaware, Lackawanna & Western Railroad at Scranton which have been treated by the Harvey cementation process, the idea being to have the top of the rail, which is exposed to wear, hard, while the balance of the rail remains soft and is not subject to danger from breakage. The following analyses give the carbon at different depths:

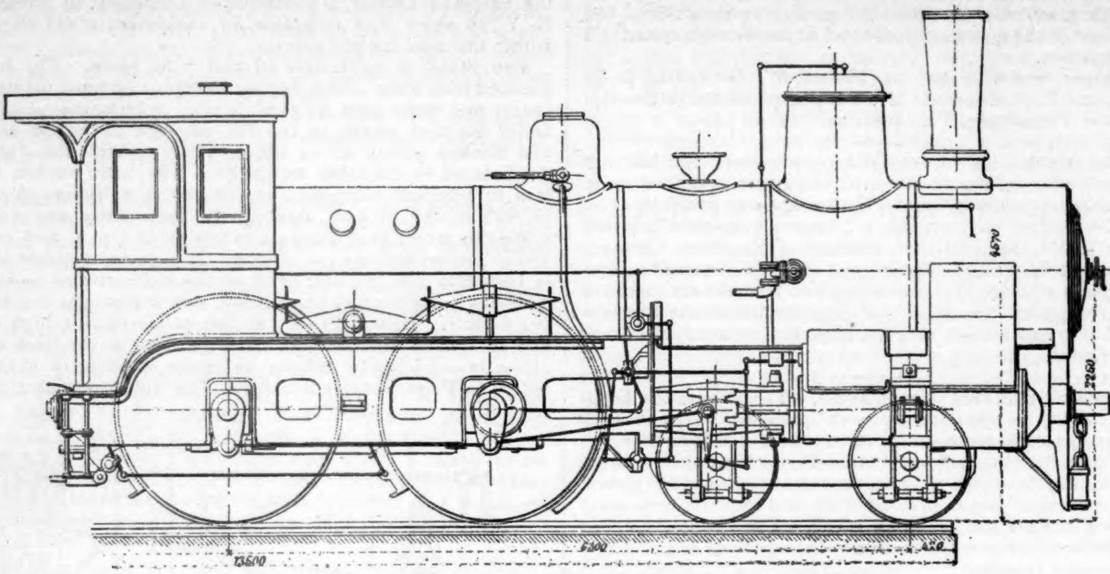
Depth. Inches.	No. 1 Rail.	No. 2 Rail.
$\frac{1}{16}$	0.76	0.76
$\frac{2}{16}$	0.42	0.42
$\frac{3}{16}$	0.33	0.31
$\frac{4}{16}$	0.30	0.30
$\frac{6}{16}$	0.30	0.30
$\frac{8}{16}$	0.33	0.30
$\frac{10}{16}$	0.30	0.27
$\frac{12}{16}$	0.30	0.28
1	0.27	0.26
$1\frac{4}{16}$	0.27	0.26
$1\frac{8}{16}$	0.27	0.25
Flange	0.24	0.27

The railroad officials report that the Harveyized rails show less wear and flow of metal than other rails subjected to service under the same conditions.—*Iron Age.*

A New Cement.—The *Revue Scientifique* notes that Mr. Takayama, a Japanese engineer, has been making use of a sand resulting from the decomposition of granite, which is found in large quantities in Japan. This sand, when mixed with lime, forms an excellent cement. Briquettes composed of 100 parts of sand and 10 parts of slaked lime, after two weeks' exposure to the air, showed a resisting power of 56 lbs. per sq.

in. ; after six weeks' exposure, this was increased to 85 lbs. Immersed in water, the resistance, after 15 weeks, was 129 lbs. to the sq. in., showing a great increase.

A Hungarian Compound Locomotive.—The accompanying illustration, from the *Revue Generale des Chemins de Fer* shows a compound locomotive for express traffic recently built for the Hungarian State Railroads. As will be seen from the sketch the engine has four driving wheels connected and a four-wheel truck. The cylinders are outside and are placed in tandem, the low-pressure cylinder being in front and the high-pressure cylinder behind, the pistons of both being connected to the same rod. The low-pressure and the high-pressure cylinders are entirely distinct castings, and the connection between them is made by means of a steam pipe which serves as an intermediate reservoir. The valve motion is outside, and is of the Walschaert type, the same valve-rod moving the valves of both cylinders. The reversing gear is of the screw type, and can be closely adjusted. The throttle valve is so arranged that live steam from the boiler can be admitted to the low-pressure cylinder, and the reversing gear is also arranged so that when it is in full gear forward or backward, live steam enters the intermediate reservoir, and consequently the low-pressure cylinders. The boiler is of steel and has a very long fire-box, with an inclined grate for burning the coal which is ordinarily used on the Hungarian Railroads, and it is a sort of lignite. The frames are of steel and of the plate type ordinarily in use in Europe, and the truck frames are also of steel plate. The boiler is built for a working pressure of 165 lbs.



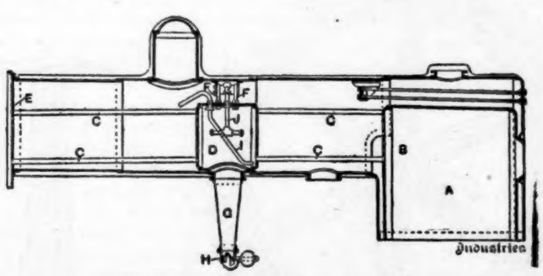
COMPOUND LOCOMOTIVE, HUNGARIAN STATE RAILROADS.

The high-pressure cylinders are 0.370 m. (14.57 in.) and the low-pressure cylinders 0.550 m. (21.65 in.) in diameter, both being 0.650 m. (25.58 in.) stroke. The ratio is 1 : 2.20. The driving-wheels are 2 m. (6.56 ft.) in diameter, and the truck wheels 1.05 m. (41.33 in.). The total weight of the engine ready for service is 119,900 lbs., of which 61,500 lbs. are on the driving-wheels and 58,400 lbs. on the truck. The conditions which this engine was built to fulfill were that it should draw a train weighing 160 tons over grades of 0.67 per cent., having curves of small radius, at the speed of 37 miles an hour, and that with the same train on a level it should be able to reach a speed of 49 miles an hour. The weight on an axle was not to exceed 14 tons. One object of the design was to secure the greatest possible amount of grate surface on account of the nature of the fuel, and also to keep down the wheel base of the engine as much as possible. The distance between the driving-wheels is 2.40 m. (7 ft. 10.46 in.), and the distance between the center of forward driver and center of truck is 3 m. (9 ft. 10 in.

Locomotive Slide-Valves below the Cylinders.—A correspondent of the *Practical Engineer* writes to that paper : "In your valuable journal, I notice a reference is made to the plan adopted by Mr. Holden, of the Great Eastern Railroad, of placing the slide-valve underneath the cylinder ; and as hundreds of locomotives have been built under my instructions with valves fixed in this way, it may, doubtless, be of some interest to many of your readers to know that my experience fully confirms the advantages which are claimed on behalf of this arrangement. Indeed, in my opinion, the plan cannot be too highly recommended. I have invariably found that plan to result in material improvement in economy over locomotives similar in other respects, but with slide-valves placed above the cylinder. In some cases this economy amounted to one-sixth, added to which the wear and tear of valves in Holden's arrangement is materially reduced, while the noisy purging-cocks can be done away with—a point, by the way, which accounts for a part of the economy. When I first introduced the arrangement I encountered much opposition, and all sorts of objections were made to the alteration. Nothing daunted, however, I continued to adopt the plan, and can now affirm that this simple change possesses, in my opinion, more value than all the patents that have been taken out during the last dozen years for improvements in locomotive engines."

The Webb Locomotive Boiler.—The accompanying sketch shows a design of boiler recently patented by Mr. F. W. Webb, Locomotive Superintendent of the London and Northwestern Railroad in England. This boiler was used in his large compound engine *Greater Britain*, which was described and illustrated in the January number of the JOURNAL.

As shown by the drawing, a combustion chamber is arranged in the barrel of the boiler between the fire-box and smoke-box tube plates so as to divide the boiler into two lengths. The general arrangement will be clearly understood from the illustration, which shows a boiler so constructed in longitudinal section. *A* is the main fire-box, and *B* its tube plate, from



WEBB'S LOCOMOTIVE BOILER.

which tubes *C* extend to a tube plate at one end of the combustion chamber *D*, and at the other end of which another tube plate has further tubes *C* leading to the smoke-bux tube plate *E*. The combustion chamber *D* is secured to the barrel of the boiler by stays *F* riveted to angle irons. At the lower part of the combustion chamber is a conical tube, *G*, closed by a valve, *H*, and weighted lever, which latter can be operated from the foot-plate of the engine, so that any ashes collected in the tube *G* may be allowed to fall out when required. *I* represents a circulating tube, of which any number may be arranged, either as represented in the illustration, or in any other suitable manner. A pipe, *J*, is also arranged to be controlled by a suitable valve which may be worked from the foot-plate, and which pipe is provided with two branches, each terminating in a rose, so that when steam is allowed to escape from them any soot or ashes will be blown from the open ends of the tubes *C*.